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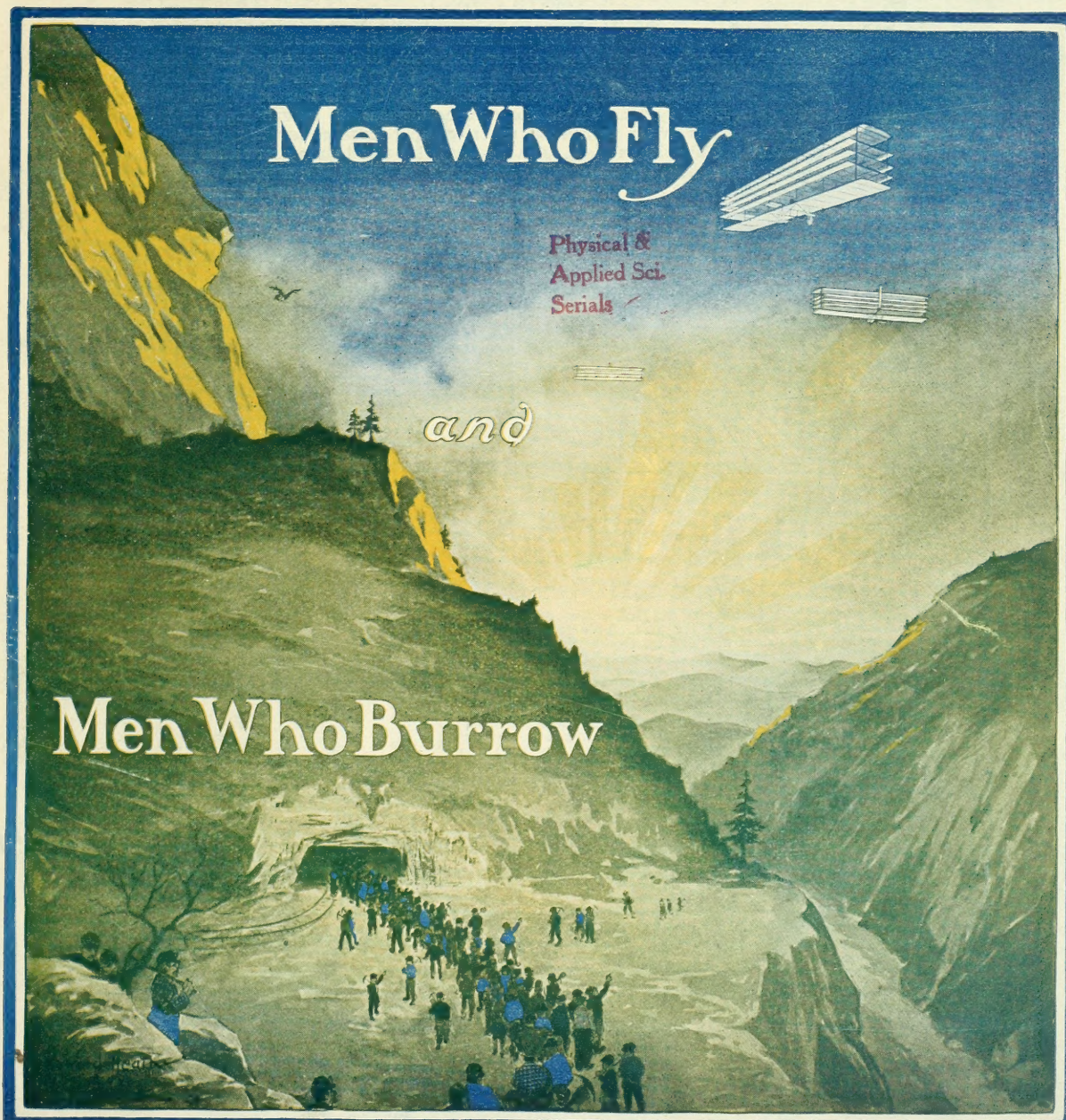

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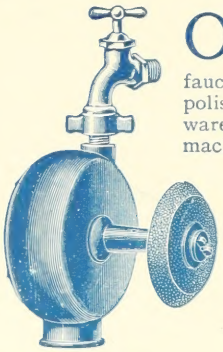

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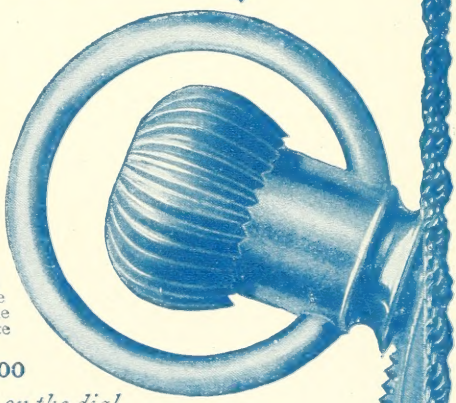

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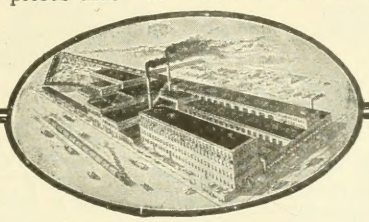

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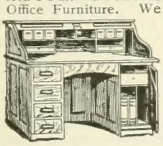

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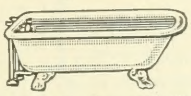

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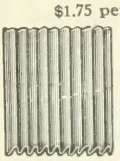

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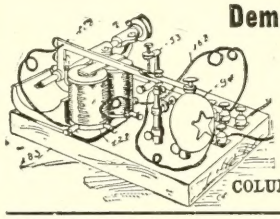

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THE TECHNICAL WORLD MAGAZINE is a monthly magazine, published the fifteenth of each month, preceding date, devoted to the problems of the technical and industrial world, and a treatment of all matters of interest in Applied Science.

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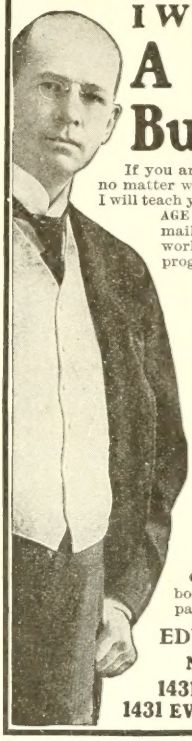

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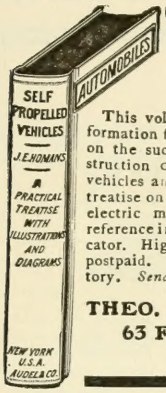

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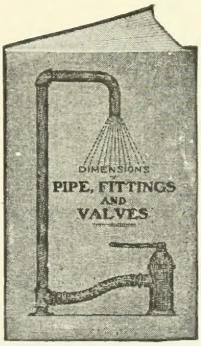

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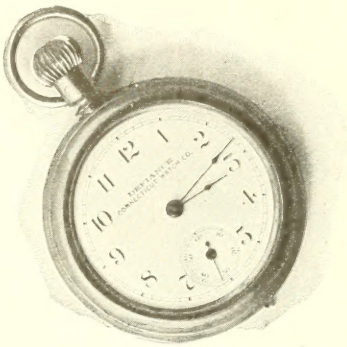

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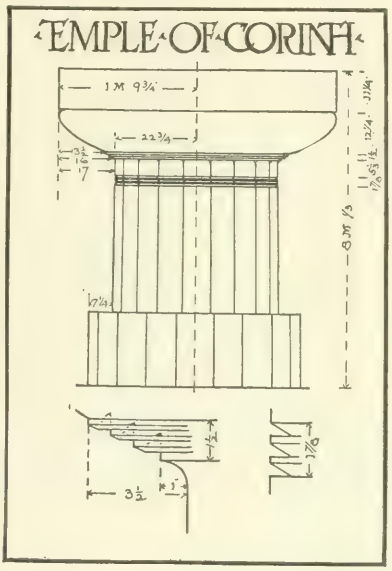

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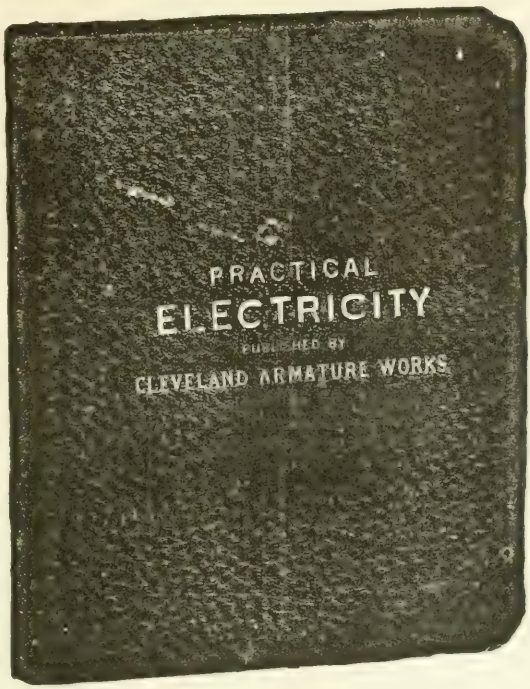

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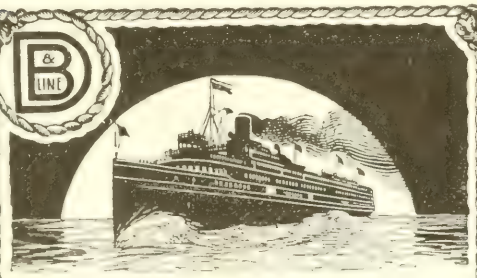

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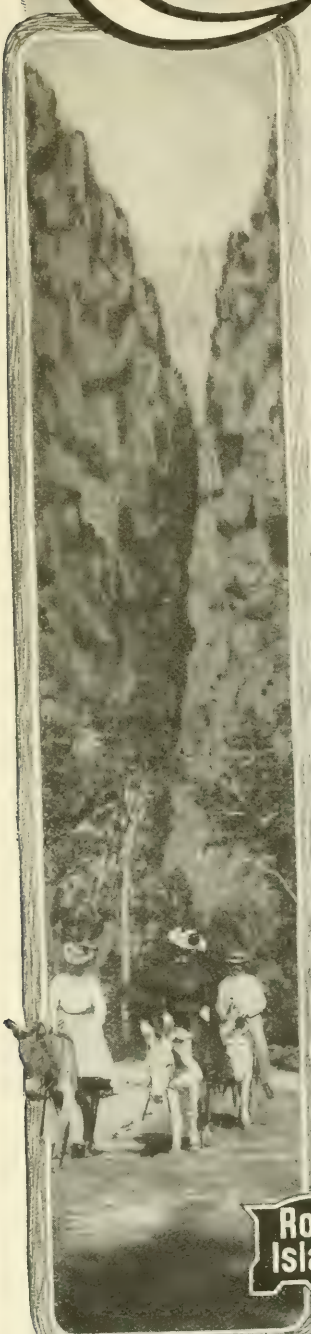

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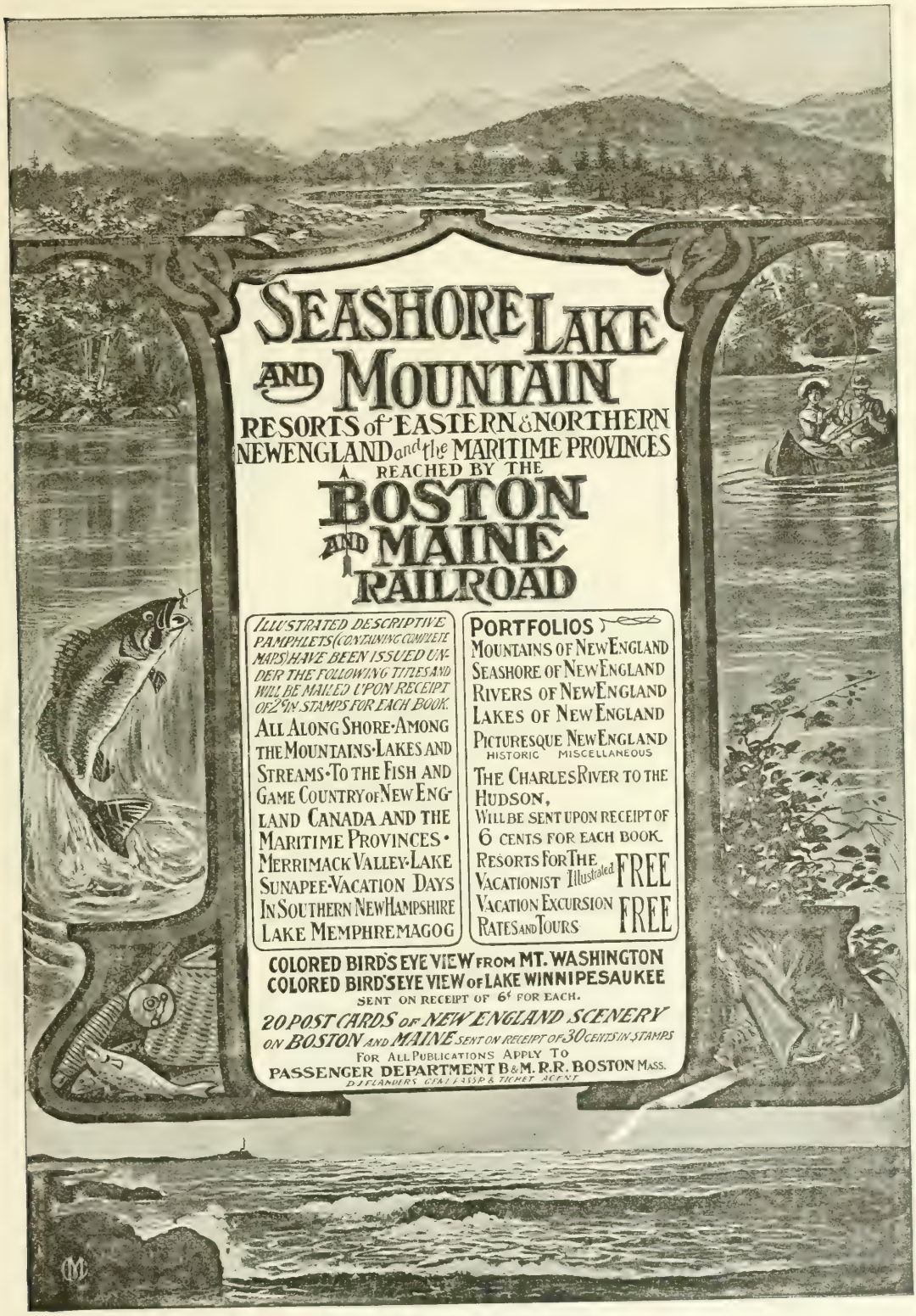
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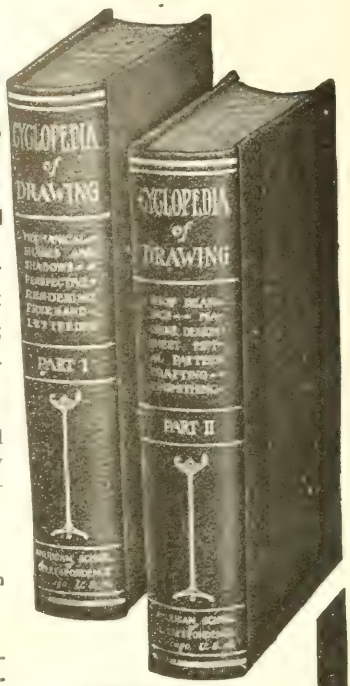

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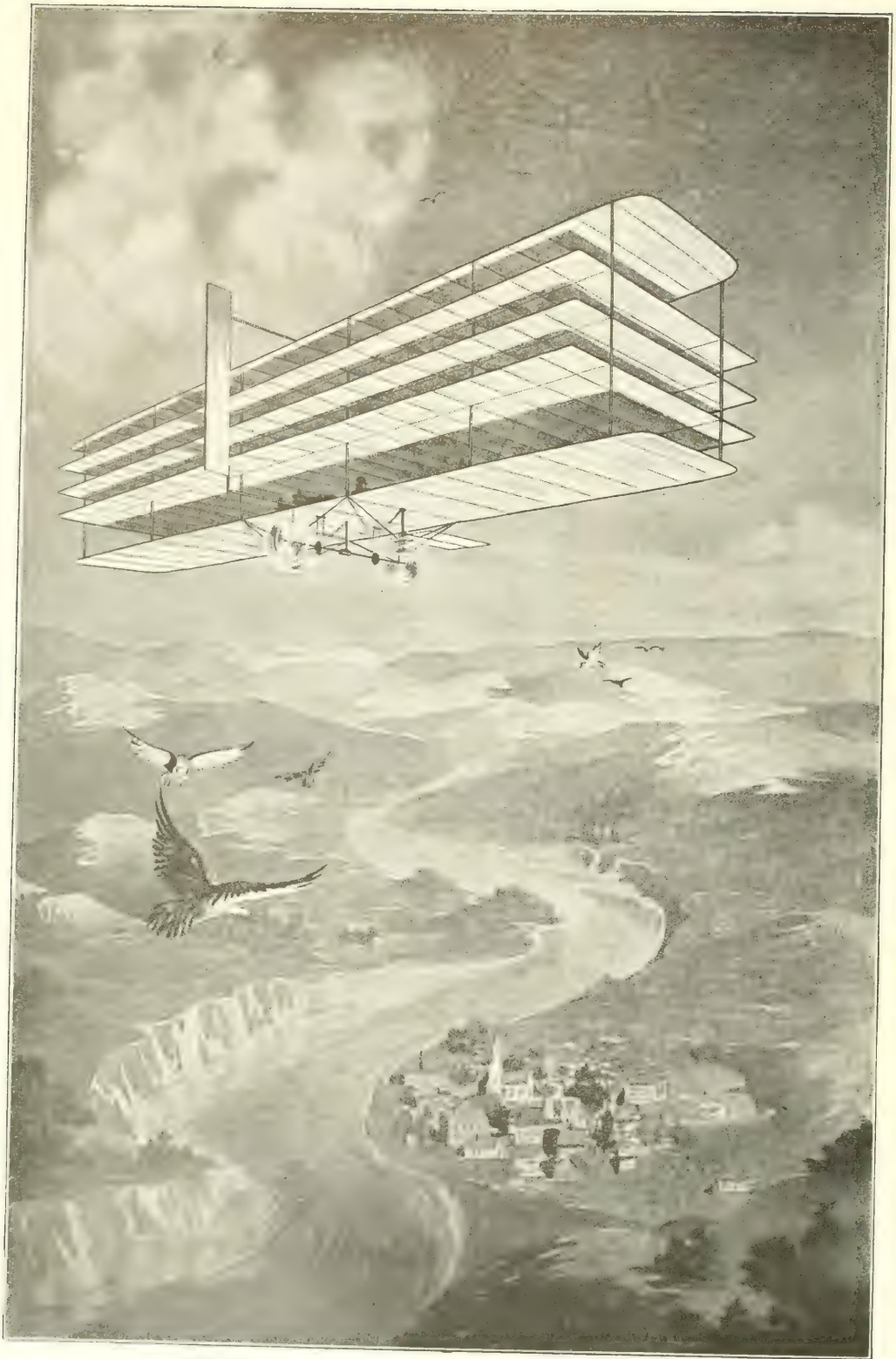

THE WRIGHT BROTHERS' FLYING MACHINE IN MID-AIR.
The sketch from which this drawing was made has been seen by the inventors.

THE TECHNICAL
WORLD MAGAZINE

Volume V JUNE, 1906 No. 4

Man May Now Fly at Will

By E. B. Grimes

THE problem of human flight is solved. One hundred and sixty times have the motor-driven flying machines invented by Orville and Wilbur Wright of Dayton, Ohio, carried a man safely through the high air. The Wright flyer weighs about 925 pounds, including the operator. It is a true flying machine—not a dirigible balloon—and owes nothing to the lifting power of any gas. It seems to be completely under the control of the operator, who can send it up or down, ahead, or to either side, at will. Driven by a gasoline engine, said to be of twenty-four horse-power, it flew on its last trip a distance of 24½ miles without a stop. The speed during this flight averaged a trifle over 38 miles an hour.

Few inventions have had such tremendous possibilities. Consider, for instance, what the exclusive possession of such a practicable flyer, capable of lifting heavy weights, would mean to a nation at war. From a secure height, every movement of its enemy over a vast territory could be constantly watched; a whole army might be wiped out, or at least thrown into confusion, by bombs hurled from the sky; great cities might be easily terrorized. War, it would almost seem, would be abolished by the common consent of mankind.

France has been quick to realize all these possibilities. Already a syndicate of French capitalists and army officers—backed, it is said, by the War Department of the Republic—have an option on the machine, which, it is believed, they will soon exercise.

In this situation the German Government has taken alarm. The Teutons see visions of a fleet of airships rising from Paris and dropping their explosive shells into the sacred precincts of Unter den Linden. They shrink at the thought of facing, even with the army of the Imperial War Lord, an almost invisible enemy which soars on wings like an eagle and sweeps over the valley of the Rhine with the speed of an express train, spreading terror in its path.

But the Germans have awakened too late to do more than rail at their successful rival, and to denounce the invention of the Wright brothers as "another American bluff." On that subject it may be well to let the inventors speak for themselves:

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A Report Which Marks an Epoch in Aërial Navigation

TO THE AËRO CLUB OF AMERICA—

THOUGH America — through the labors of Professor Langley, Mr. Chanute, and others, had acquired not less than ten years ago the recognized leadership in that branch of aëronautics which pertains to bird-like flight, it has not heretofore been possible for American workers to present a summary of each year's experiments to a society of their own country devoted exclusively to the promotion of aëronautical studies and sports. It is with great pleasure, therefore, that we now find ourselves able to make a report to such a society.

Previous to the year 1905, we had experimented at Kitty Hawk, North Carolina, with man-carrying gliding machines in the years 1900, 1901, 1902, and 1903; and with a man-carrying motor-flyer, which, on the 17th day of December, 1903, sustained itself in the air for fifty seconds, during which time it advanced against a twenty-mile wind a distance of 852 feet. Flights to the number of more than one hundred had also been made at Dayton, Ohio, in 1904, with a second motor-flyer. Of these flights, a complete circle, made for the first time on the 20th of September, and two flights of three miles each, made on the 9th of November and the 1st of December, respectively, were the more notable performances.

The object of the 1905 experiments was to determine the cause of, and discover remedies for, several obscure and somewhat rare difficulties which had been encountered in some of the 1904 flights, and which it was necessary to overcome before it would be safe to employ flyers for practical purposes. The experiments were made in a swampy meadow about eight miles east of Dayton, Ohio, and continued from June till the early days of October, when the impossibility of longer maintaining privacy necessitated their discontinuance.

Owing to frequent experimental changes in the machine, and the resulting differences in its management, the earlier flights were short; but towards the middle of September, means of correcting the obscure troubles were found, and the flyer was at last brought under satisfactory control. From this time forward, almost every flight established a new record. In the following schedule, the duration, distance, and cause of stopping are given for some of the later flights:

DATE	DISTANCE	TIME	CAUSE OF STOPPING
Sept. 26	17,961 meters (11⅛ miles)	18 min. 9 sec.	Exhaustion of fuel
Sept. 29	19,570 meters (12 miles)	19 min. 55 sec.	Exhaustion of fuel
Sept. 30		17 min. 15 sec.	Hot bearing
Oct. 3	24,535 meters (15¼ miles)	25 min. 5 sec.	Hot bearing
Oct. 4	33,456 meters (20¾ miles)	33 min. 17 sec.	Hot bearing
Oct. 5	38,556 meters (24⅛ miles	38 min. 3 sec.	Exhaustion of fuel

It will be seen that an average speed of a little more than 38 miles an hour was maintained in the last flight. All of the flights were made over a circular course of about three-fourths of a mile to the lap, which reduced the speed somewhat. The machine increased its velocity on the straight parts of the course, and slowed down on the curves. It is believed that in straight flight the normal speed is more than forty miles an hour. In the earlier of the flights named above, less than six pounds of gasoline was carried. In the later ones a tank was fitted large enough to hold fuel for an hour, but by oversight it was not completely filled before the flight of October 5th.

In the past three years a total of 160 flights have been made with our motor-driven flyers, and a total distance of almost exactly 160 miles covered, an average of a mile to each flight; but until the machine had received its final improvements, the flights were mostly short, as is evidenced by the fact that the flight of October 5th was longer than the 105 flights of the year 1904 together.

The lengths of the flights were measured by a Richard anemometer, which was attached to the machine. The records were found to agree closely with the distances measured over the ground when the flights were made in calm air over a straight course; but when the flights were made in circles, a close comparison was impossible, because it was not practicable to trace the course over the ground accurately. In the flight of October 5th, a total of 29.7 circuits of the field was made. The times were taken with stop-watches. In operating the machine it has been our custom for many years to alternate in making flights, and such care has been observed that neither of us has suffered any serious injury, though in the earlier flights our ignorance and the inadequacy of the means of control made the work exceedingly dangerous.

The 1905 flyer had a total weight of about 925 pounds, including the operator, and was of such substantial construction as to be able to make landings at high speed without being strained or broken. From the beginning, the prime object was to devise a machine of practical utility, rather than a useless and extravagant toy. For this reason, extreme lightness of construction has always been resolutely rejected. On the other hand, every effort has been made to increase the scientific efficiency of the wings and screws in order that even heavily built machines may be carried with a moderate expenditure of power. The favorable results which have been obtained have been due to improvements in flying qualities resulting from more scientific design, and to improved methods of balancing and steering. The motor and machinery possess no extraordinary qualities. The best dividends in the labor invested have invariably come from seeking more knowledge rather than more power.

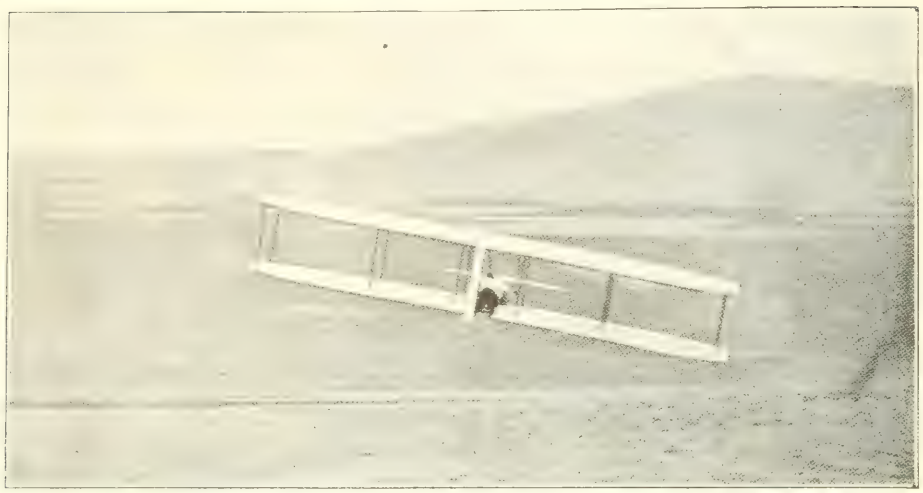
(Signed) WILBUR WRIGHT
ORVILLE WRIGHT

After receipt of this report, the following resolutions were adopted by the Board of Directors of the Aëro Club:

"*Whereas,* the Messrs. Wright Brothers, Wilbur and Orville, of Dayton, Ohio, have developed an aëroplane type of flying machine that many times has carried a man safely through the air at high speed and continuously over long distances, and is therefore of practical value to mankind; therefore be it

"*Resolved,* that the Aëro Club of America hereby expresses to them its hearty felicitations on their great achievement in devising, constructing, and operating a successful man-carrying dynamic flying machine; and, be it further

"*Resolved,* that a copy of these resolutions be addressed to Messrs. Wilbur and Orville Wright, at Dayton, Ohio."



TURNING IN THE AIR.

But the claims made for the Wright flyer do not rest on the word of the two inventors, though no one who knows them would doubt for an instant any statement either of them would make.

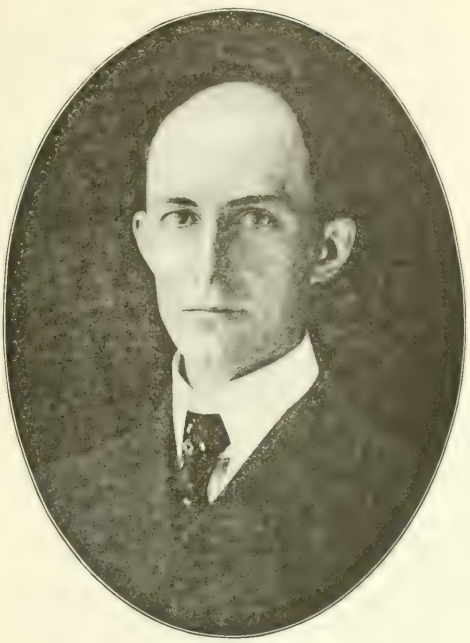
It is true that they have never made a public exhibition of their machine. That is because they preferred to perfect their apparatus in secret, without attempting to protect themselves by taking out any patents. But they have at various times invited a number of friends to watch their flights. Among these witnesses, who have actually seen the machine carrying a man through the air, and all of whom are men of high standing, are the following: Mr. E. W. Ellis, Assistant Auditor of the City of Dayton; Mr. Torrence Huffman, President of the Fourth National Bank; Mr. C. S. Billman, Secretary of the West Side Building Association; and Messrs. Henry Webbert, W. H. Shank, Wm. C. Foutz, Frank Hamburger, Chas. Webbert, Howard M. Myers, Bernard H. Lambers, Reuben Schindler, and Wm. Weber, all of Dayton, Ohio; Mr. O. F. Jamieson, E. Germantown, Ind.; Mr. Theodore Waddell, of the Census Bureau, Washington, D. C.; and Messrs. David Beard and Amos Stauffer, of Osborn, Ohio.

ORVILLE WRIGHT.

All of these men are under pledge not to reveal any of the details of the airship's construction or of its operation; but they are all nevertheless enthusiastic over what they have seen, and in several cases they have made statements of a general character to the press. Following is the testimony of two of the witnesses as printed in the *Dayton Evening News:*

"It just sailed right off the ground like a bird. It sailed round and round until they got ready to come down. Then it lit like a duck on the water."—WILLIAM WEBER.

"When I went out to Huffman Prairie, I expected to see somebody's neck broken. What I did see was a machine weighing nine hundred pounds soar away like an eagle. When they were in the air about sixty feet, they pointed its nose to a horizontal line and sailed round and round like a great bird. No wavering, no ducking up and down. It just sailed around the ring like it had been running in a groove. Yes sir; the flying machine has arrived, and it was born in Dayton, Ohio."—W. C. Foutz.



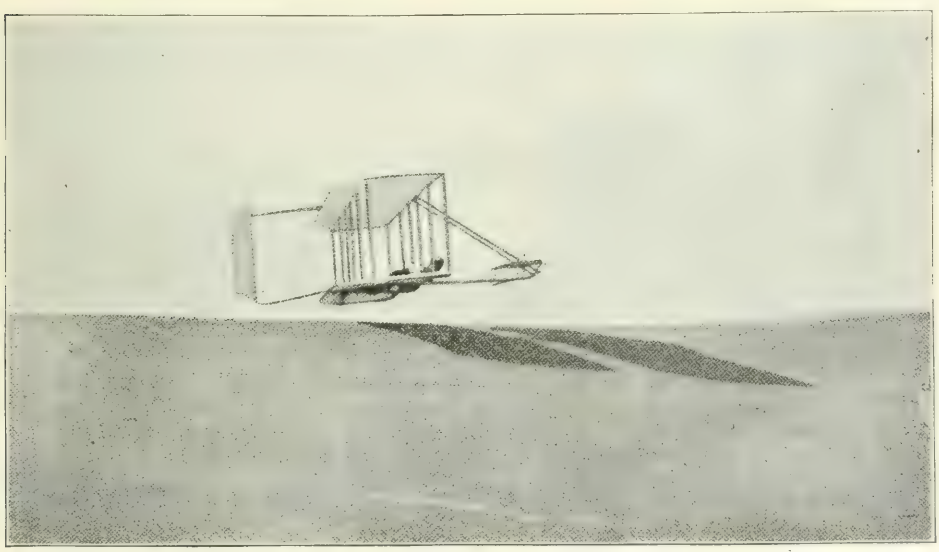
Wilbur Wright.

What is the form of the Wright flying machine? Of what materials is it constructed?

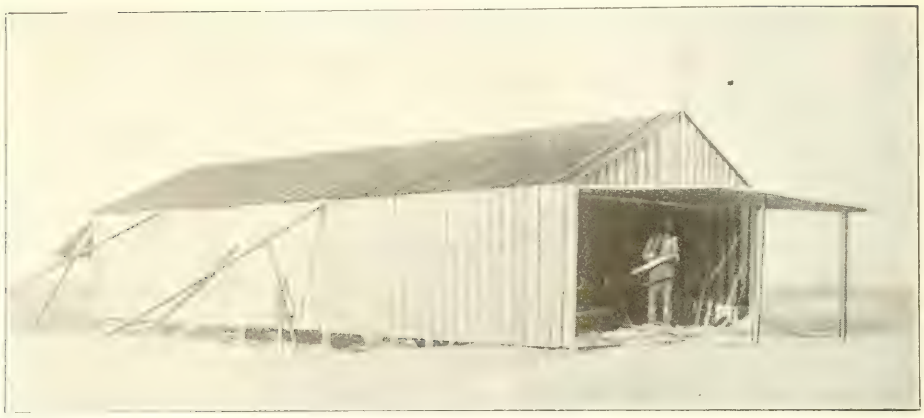
These questions cannot be answered in detail, for, as stated above, those who have seen the machine in flight and even the men who have worked on its construction are pledged to complete secrecy.

It may be said, however, that the Wright flyer is constructed of spruce wood, second-growth ash, steel wire, heavy muslin, and a very small percentage of metal. It is not at all bird-like in shape, early experiments having demonstrated that it was not feasible to build such a machine when more than thirty or forty pounds was to be carried. Imagine to yourself a structure about eighteen feet long, consisting chiefly of an upper and a lower deck or rectangular framework, the width of each being about seven feet. The two decks are about three feet apart and are held together by uprights, between which are stretched small wings or slats, like those of an old-fashioned window-blind.

In the center, between the two decks, is located the gasoline motor that drives the propellers, which are placed imme-



SKIMMING ALONG CLOSE TO THE GROUND.



AËROPLANE SHED USED BY THE WRIGHT BROTHERS DURING EXPERIMENTS.

diately below the lower deck. The operator reclines at full length on the lower deck, face downward.

A striking feature of the machine is the horizontal rudder at the front, which has much to do with maintaining the equilibrium of the car when in motion.

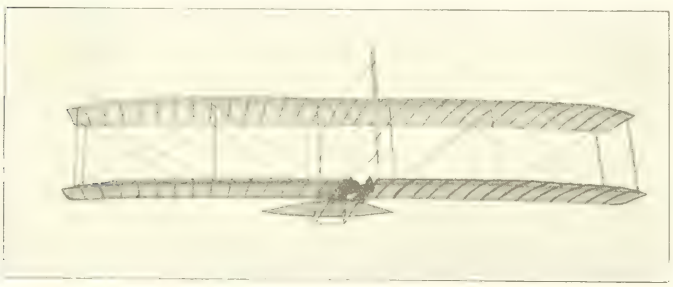
In starting, the car is pushed by hand for a few feet along a single rail. Then, as the propellers make themselves felt, it gradually mounts into the air, and, rising or falling at the will of the operator, sweeps ahead or to one side in response to its rudder. No difficulty is found in keeping the machine on an even keel; and, in alighting, the great fabric comes to the ground so gradually and easily that the shock is barely felt. In moving through the air, the flyer goes broadside.

One remarkable thing in connection with the work of the Wright brothers, is the fact that, although they have been experimenting for years with gliding and flying machines, neither of them has ever met with a serious accident of any kind.

Among those who early interested themselves in the aërial experiments and ambitions of the Messrs. Wright, was a well-known resident of Paris, an officer in the French Army. He has been in almost constant communication with the inventors for some years, and it was through his interest and at his suggestion that M. Arnold Fordyce of Paris, representing a syndicate of French capitalists and—it is said—the French War Department, came to Dayton a few months ago to witness a test of the perfected flyer.

So delighted was he at the result of the trials he witnessed, that before leaving he had secured on behalf of his principals an option on the machine. The exact terms of this option have not been made public, though, according to a widely circulated report, it provided for a payment of $25,000 down and a further payment of $300,000 when the option was closed.

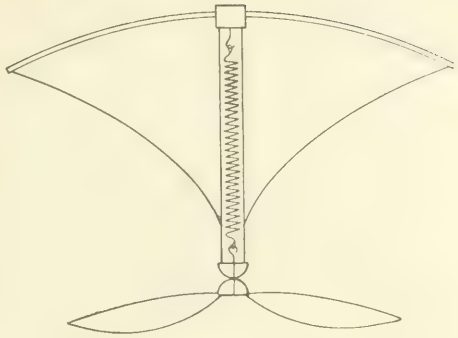
During early April, M. Fordyce again visited the Wright brothers at Dayton. This time he was accompanied by MM. H. Bonel and R. Fournier, of Paris, and Mr. W. R. Berry, of Washington, D. C., who is counsel for some of the foreign legations there. M. Fordyce stated that the object of this visit was not to close his option on the Wright flyer, though, under the circumstances, he could hardly be expected to admit the facts until the deal is closed.



A WRIGHT MOTORLESS GLIDING MACHINE IN FLIGHT.

Wilbur and Orville Wright are men of thirty-nine and thirty-five years of age, respectively. Wilbur was born in Millville, Indiana, and his brother in Dayton, where the family has resided for years. While they were still young boys, their father, Bishop Milton Wright, brought home with him as presents to his sons a couple of specimens of Penaud's Helicoptere, or lifting screws, an ingenious toy which, operated by rubber cords, is able to raise itself in the air. At once both the boys were fascinated. They took the toy carefully apart, built others like it, and even attempted to build larger models on the same plan. They found, however, that lifting screws materially larger than the original would not fly. And from that time on, the idea of some day solving the problem of flight has been in their minds.

After finishing their studies at the Dayton High School, the Wright brothers entered a printing office in that city and learned the trade of compositors. Later they were for some time employed in the office of *The Conservator,* a United Brethren church paper, at that time published by their father. With the coming of the bicycle craze, they opened a shop for the sale and repair of wheels, as being more in line with their natural taste for mechanics. All this time they were earnest students of aëronautics, and they have gathered a large and comprehensive collection of literature on the subject.



HELICOPTERE, A SELF-RAISING FLYING TOY.
It first suggested the aëroplane to the Wright brothers.

For the past four years they have devoted practically all of their time to the perfection of their airship. When it became evident that success was near, if not already accomplished, they received several offers of financial backing, but declined them all, preferring to depend entirely on their own resources.

They live in a modest home in Dayton, with their aged father and one sister,

WRIGHT BROTHERS' MOTORLESS GLIDING MACHINE IN FULL FLIGHT.

who is a teacher of Latin in the Dayton High School. From the beginning, they have had the support and encouragement of their family in the work; and now, when their invention is perfected, and man's mastery of the upper air is within sight, they share with father and sister the congratulations and more substantial rewards which are coming to them from all parts of the world.

McGinnis and the Union Label

By Wm. F. Kirke

Mr. Joseph A. McGinnis was for unions all the way,
He favored larger wages and a somewhat shorter day.
A walk-out always pleased him though he did'nt have a cent;
But when the delegate said strike, McGinnis always went.
He did the shopping for his wife because he liked to know
That nought save union articles were purchased with his dough.

Has it got the union label? McGinnis used to say.
Has it got the union label? Show it to me if you're able;
If it hasn't got the label, take the bloomin' thing away.

McGinnis had no children though he hoped to have some day,
And his wife who "seen her duty" was opinioned the same way;
So when the stork arrived one day and brought a bouncing boy,
McGinnis was elated—he was overcome with joy,
He looked the baby over—his face wreathed in a grin,
When all at once a thought occurred which filled him with chagrin—

Has it got the union label? McGinnis used to say.
Has it got the union label? Show it to me if you're able;
If it hasn't got the label, take the bloomin' thing away.

Now Joseph A. McGinnis was a man of good repute;
He went to church on Sunday in his union-tailored suit;
Like many other union men, he led a blameless life;
And when he died, the neighbors said, "The blow will kill his wife."
He reached the pearly gates on time, as upright spirits do;
"Welcome!" was Peter's greeting, and "I have a harp for you."

Has it got the union label? McGinnis used to say.
Has it got the union label? Show it to me if you're able;
If it hasn't got the label, take the bloomin' thing away.

—EXCHANGE.

BAY OF NAPLES, WITH MT. VESUVIUS IN THE DISTANCE

On the Lid of a Pit of Fire

By John L. Turner

THE destruction of the city of Naples by volcanic eruption was predicted by John Elfreth Watkins in THE TECHNICAL WORLD MAGAZINE for January, 1905. How nearly that grim prophecy came to fulfillment in April last, all the world knows. For more than a week, Vesuvius rocked and thundered, pouring out streams of lava which destroyed hundreds of lives and ruined property to the estimated value of $20,000,000. For a week the Neapolitan lived in terror, while thick, sulphurous smoke from the crater turned their gay streets into dark and gloomy canyons, and a rain of brown ashes fell inches thick over all the city.

It is difficult to imagine a more striking and picturesque spectacle than that of the terrified poor of swarming Naples, following in processions through the black and gloomy streets the sacred relics of San Januarius, and calling, with fear-stricken voices, upon their patron saint to save them from the death which imminently threatened them.

This last eruption of Vesuvius devel-

VESUVIUS IN ERUPTION.

oped its heroes. When repeated shocks of earthquake and belching from the mountain had thrown the people of Naples—the most densely populated city in the world—into a wild panic, King Victor Emmanuel and Queen Helena hurried from Rome to the stricken city, forced to walk twelve miles through ashes which covered the roads to the depth of three feet.

But the one great hero of the cataclysm is Professor Matteucci, Director of the Royal Observatory, which is located high up on the side of the mon-

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DESOLATING EFFECT OF VOLCANIC ERUPTION.
Ruins of St. Pierre, Island of Martinique. Destroyed by eruption of Mt. Pelée, May, 1902.

and, by showing a fine, royal disregard of dangerous conditions, succeeded in quieting the fears of the people and bringing something like order out of the wild riot of dread. King Victor personally visited many of the ruined towns and villages in the zone about the base of the mountain, undergoing great personal risk in order to do what he could to relieve the suffering of his subjects. The Princess of Schleswig-Holstein was another royalty who showed great courage. On April 12 she set out from Naples in her automobile to carry supplies to the injured in the hospitals about the base of the mountain. Her machine finally became disabled, and she was ster. At imminent and constant risk of his life, Professor Matteucci remained at his post through tens of terrific convulsions, taking observations and making records, while the floor of the Observatory rocked under his feet and the air was filled with huge stones thrown up by the volcano.

When the eruptions had somewhat subsided, Professor Matteucci made the following statement to a correspondent of the Associated Press:

"I first observed Mount Vesuvius giving unusual signs about a month ago, when the lava began to overflow, taking a southwest direction. This gradually increased as several small lava streams formed into one great current.

ROYAL OBSERVATORY, NEAR SUMMIT OF VESUVIUS.
Prof. Matteucci and his American assistant, Prof. Perret, remained heroically at their posts here during the recent eruption.

"Our really terrible period came at 3 o'clock Sunday morning, April 8, and lasted until 8 o'clock. The mountain, which hitherto had been silent, suddenly gave out a deafening roar and a great rent was made in its cone. Huge solid rocks were hurled skyward. Some of them fell near the Observatory, threatening to crash in the roof, but most of them fell far outside the Observatory zone. There was no scoria in this first discharge, but many solid, bullet-like stones, which cut the roof and damaged the windows.

"At midnight of Saturday, I ordered the women and children of the household removed. This was just before the rain of huge stones began, and I was then left with Professor Perret of New York, my American assistant, and two domestics. There was scarcely any eating, and all domestic order was abandoned. We snatched a few bites now and then; most of the time I ate right here.

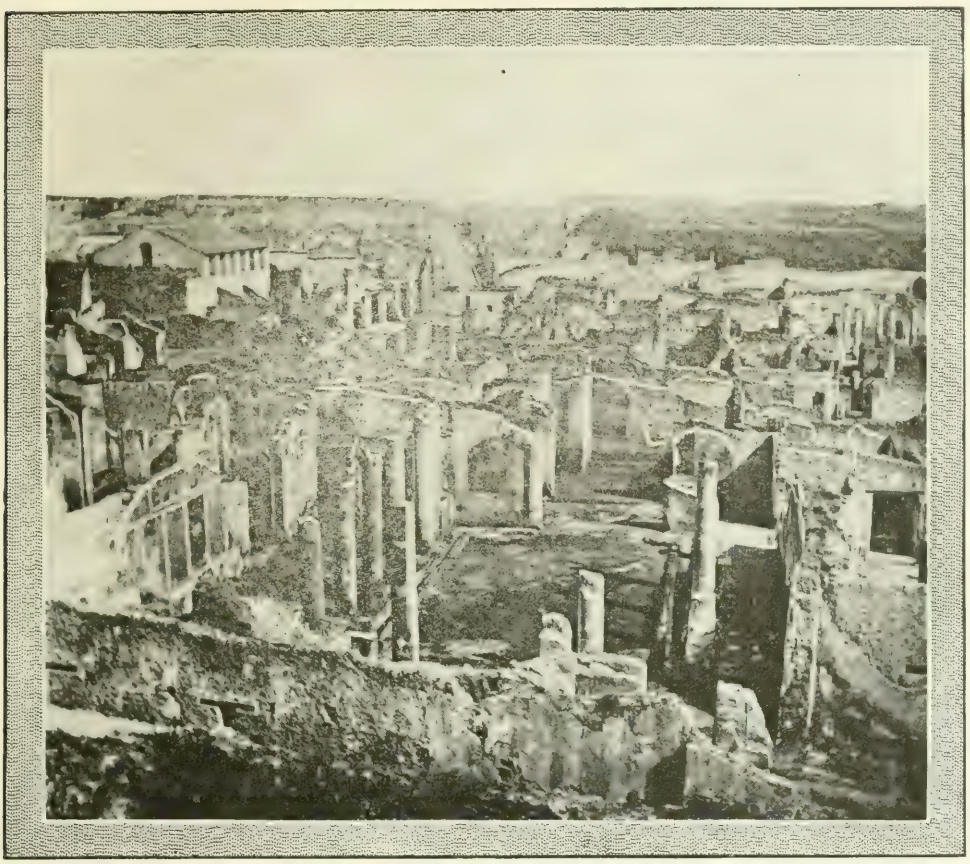
"Throughout Sunday enormous solid blocks of stone rose to a height of 2,500 feet from the crater, while ashes and sand were thrown much higher, but towards Monday the terrible shocks of earthquake gradually diminished. One of the worst features of the eruption was the unusual extent of the electrical phenomena, the darkness being broken by vivid flashes of lightning, giving the sky a blood-like color, with short, heavy peals of thunder interspersed. These moments were terrible—terrible. Yes, it was a veritable hell.

"Compared with other great eruptions," con-

RACK SECTION OF RAILWAY WHICH RAN TO MOUTH OF CRATER ON MT. VESUVIUS.
This railway was entirely destroyed by the last eruption of the mountain.

tinued the observer, "this is one of the most important in the history of Vesuvius. Its effects are less terrible than those of the eruption in the year 79, when Pompeii was buried, but it equals in intensity the great eruptions of 1631 and 1872."

Asked concerning Mount Vesuvius in the future, Professor Matteucci replied:



PANORAMA OF THE RUINS OF POMPEII, OVERWHELMED BY VESUVIUS IN 79 A. D.

"I am unable to tell with any degree of certainty. I sincerely hope this eruption is over; but who can tell whether another terrible convulsion may not come during the next minute?"

Even as he spoke, Vesuvius gave another deep groan, ending with a fearful explosion which blew off a portion of its new cone.

"See," exclaimed the Professor, "the eruption may be resumed at any moment. That explosion rent the westerly cone."

Sharing with Professor Matteucci the great danger of remaining in the Observatory, was Prof. Frank A. Perret of New York. This is the statement made by him:

"The most terrible moment came Saturday night. I had gone to Boscotrecase for the purpose of photographing the lava stream that was then deluging that town. I returned to the Observatory about midnight. The dynamic force of the main crater increased enormously, and new crater mouths opened in the mountain side within ten minutes of each other. This caused immense havoc.

"At midnight the situation in the Observatory was terrible. The ground rocked under it, and it was impossible to stand firmly on one's feet. The roaring of the main crater was deafening; the volcano operated like a fountain, its discharges rising and spreading and then falling over a great area. The electric phenomena were terrifying. The claps of thunder were incessant, with a lurid play of lightning. The cause of the phenomena was friction from the ascending particles generating electricity, which displayed itself in incessant lightning and thunder-claps.

"No one thought of sleep, but all stood gazing at the awful scene. At 3 o'clock in the morning, the lowest station seemed to be burning, and at 3:30 o'clock the whole cone broke open with a tremendous earthquake shock. Red-hot projectiles were precipitated toward

TOURISTS ON THE BRINK OF THE CRATER OF VESUVIUS.

Mount Somma and the Observatory. That seemed to be the critical moment, and the brigadier of the carbineers ordered a retreat. We made our way to a small house down the mountain side, but even there the rain of stones continued. One of the carbineers was struck on the head and badly cut. After this the intensity of the eruption steadily decreased."

The bravery shown by Professor Matteucci has already been recognized by King Victor, who has made the scientist a commander of the Order of the Crown.

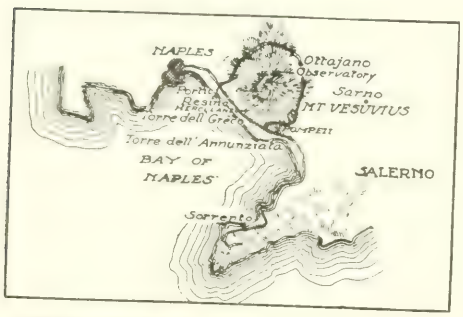
One of the remarkable things about Naples and the country around it, is the fact that the villages about the slope of the mountain have been destroyed time after time; yet, no sooner does Vesuvius subside and the ashes and lava cool, than people again swarm back to the site of their old homes and rebuild the ruins. About the whole base of the mountain, sweeps a wide road, beginning and ending at Naples. Along this road more than 100,000 people live in a closely-set series of villages. Sixteen times before the present eruption, has lava overwhelmed Torre del Greco, again destroyed in the present catastrophe. Yet it is safe to say that within a year or two

LAVA MOUNDS NEAR THE CRATER OF VESUVIUS.

VIEW SHOWING ALL THAT PART OF THE BURIED CITY OF HERCULANEUM WHICH IS NOW UNCOVERED.
In the background smokes the dread volcano which overwhelmed the city along with Pompeii and other places in 79 A. D.

SAN VITO STATION ON LINE OF TROLLEY UP MOUNT VESUVIUS.
Royal Observatory in the distance.

it will again rise on top of the ashes and that the vineyards about it, now deep-



MAP OF REGION AFFECTED BY PRESENT ERUPTION OF MOUNT VESUVIUS.

buried under scoria, will again be planted with grapes.

Before the Christian era, Vesuvius was not recognized as an active volcano. The first eruption in centuries occurred in 63 A. D., followed sixteen years later by the historic outbreak which overwhelmed Pompeii and Herculaneum. The first recorded discharge of lava afterwards was in 1036 A. D. During the eighteenth and nineteenth centuries the eruptions have gained in frequency. In 1822 and 1834 there were outbreaks; and in 1855, lava flowed almost to the gates of Naples. In 1867, 1872, 1879, 1900, 1903, and 1904, the volcano was active, and several times the villages on the slope were destroyed.

So far, the Observatory, which was originally built sixty years ago, has escaped serious damage; while Naples, on the shore of its world-famous bay, has also never been invaded by anything worse than showers of ashes and volcanic sands. But there is yet danger that before many years some new Bulwer-Lytton will be given an opportunity of writing the tragic story of its last days.

King Coal and His Subjects

By Frederic Blount Warren

UP in the hill country of Western Pennsylvania, the 6 o'clock whistle blows in vain these bright spring mornings. Here, in a little territory not more than forty-five miles in width and seventy-five in length, practically all the anthracite coal in the United States is mined. Last year the production was the largest on record—a total of 69,400,000 long tons. The owners of the richest gold mines are poverty stricken in comparison with the men who control this exhaustless field of riches.

But now the mines are idle. On April 1, practically all of the 155,000 mine employees went on strike. They demand a ten per cent increase in wages and an eight-hour working day. The coal-owning railroads and operators declare that if they grant these demands they will be obliged to add $1.20 to the selling price of each ton of coal. The public must pay the bill. The public—the patient, long-suffering consumer—always pays.

What are the conditions of life in the coal-mine country? Who are these men whose demands may add another dollar to the price of each ton you put into your coal-bin this summer? How do they live? What do they earn, and how do they earn it?

Coal, it should be understood, is King in the anthracite country. Even in cities like Scranton, with a population of more than 100,000, the coal miners, their families, and their "bosses," are the predominating influence. Of the 155,000 actual mine employees, more than 50,000 do their work on the surface of the ground.

A GROUP OF "BREAKER BOYS."

Hundreds of these children, many of them less than sixteen years old, work long hours picking bits of slate and rock from the freshly mined coal. Most of them become coal miners.

COAL-STORAGE PLANT AT SOUTH PLAINFIELD, LEHIGH VALLEY.

Such are the old men and the little boys who work in the breakers—tall buildings in which the coal, fresh from the mines, slides by gravity down over screens of various sizes to the cars beneath. It is the business of the breaker boys to pick out from the unending procession of coal all bits of slate, rock, and other impurities. Hundreds of other men are employed in taking care of the machinery at the mouths of the mines, in handling the coal cars, and in performing other necessary work.

Throughout the anthracite country the first whistle blows at 6 o'clock in the morning. Then activity begins in the long rows of little wooden huts where the miners live. Within half an hour, men pour out of the doors and start for the mouth of the pit where they are employed. In all, there are 100,000 men to descend or to be lowered into the depths before 7 o'clock; for in most cases miners are not allowed to go down after that hour. They carry with them picks or shovels or some other tools, and their eyes are blinking in the glare of unaccustomed sunlight. Often they wear above the waist only a grimy undershirt, and the knees of their trousers show the effects of much kneeling on the floors of low galleries. But always—though other signs be all lacking—one may tell the underground mine-worker by the little safety-lamp which he wears on the front of his cap.

A "BREAKER" IN FULL OPERATION.

Out of 100,000 who daily go down into the bowels of the earth—some of them to the bottom of pits 2,000 feet deep—only about half are actually engaged in the mining of coal. The others are bosses of one kind or another, are intrusted with the working of the ventilating systems, are timbermen whose duty it is to see that the system of wooden supports keeps the galleries from caving in, or, perhaps, are drivers and stablemen. The work of the latter is to care for the mules which pull the little cars of coal to the bottom of the shafts. Hundreds of these animals are stabled underground in a

large mine. One of the photographs shows a herd of mine-mules which are breathing the surface air and enjoying the sunlight for the first time since the great strike of 1902.

On landing at the bottom of the pit, some of the miners may have to go one mile, or even two, in order to reach the chamber or "breast" in which they are at work. Methods of work—and of pay, as well—differ in the various districts and in the different mines. In some cases the miners work in pairs, blasting and cutting out the loosened coal, which is then loaded into cars by laborers employed and paid by the miners themselves. In other cases the company employs the men who do the loading.

Generally speaking the miners are paid on the piece-work system, their gross earnings varying according to the amount of coal they deliver to the cars. Various methods of estimating the product of each miner are employed, and it is of these methods that many of the most serious complaints have been made. In most mines the miners employ a weighmaster or gauger of their own, who checks up the work of the company's officials and sees to it that the men below ground get a square deal when the coal they have dug reaches the surface and passes under the eye of the company's estimator.

TYPICAL MINER ON HIS WAY HOME.

On the average, the miners in the anthracite coal region earn about $540 a

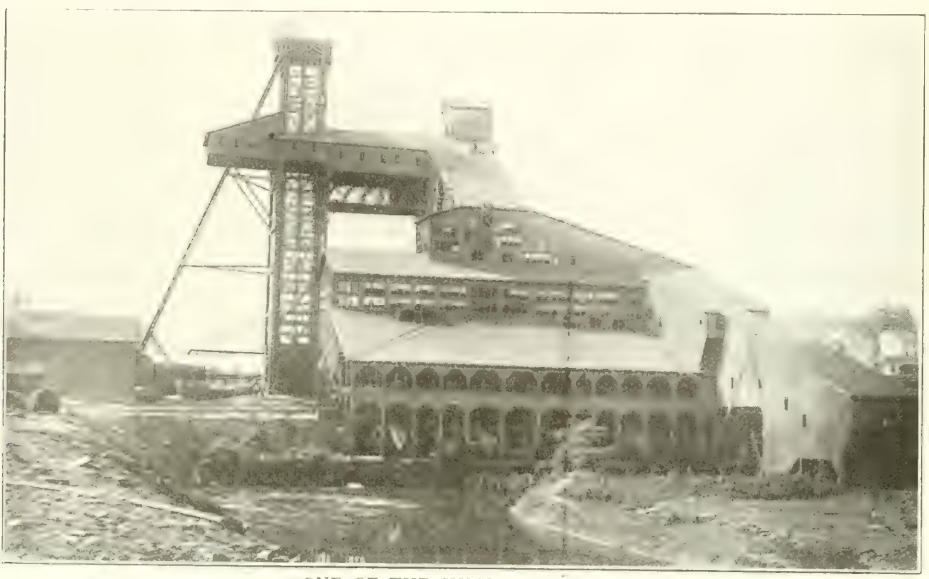
STREET OF MINERS' HOMES IN A PENNSYLVANIA COAL-MINING TOWN.

For these shacks, most of them owned by the mining companies, a monthly rental of from $2 to $8 is charged.

LOOKING FOR COAL IN THE CULM HEAPS AT THE MINES.

year each. But a miner cannot go to work empty-handed. As the first condition of his employment he must have a miner's certificate from the State Board of Examiners. This certificate sets forth that the person named has had two years' experience as a miner in Pennsylvania; that he has successfully passed an examination as to his knowledge of the work, making answer in the English language to the questions asked him. It must also bear the endorsement of an experienced miner, identifying the person to whom the certificate is issued and testifying to personal knowledge of his experience. The legal fee for such a certificate is $1.00. But it is notorious that for a slightly higher fee a fraudulent certificate can be secured, and there are said to be many miners at work who have not been in the United States more than a few months, and who cannot answer the simplest question in the English language.

The danger of having such inexperienced and ignorant men at work may be judged by the fact that in more than three-quarters of all the mines in the anthracite region noxious or explosive gases are spontaneously generated, which may be ignited at any time by a moment's carelessness. Every day there are severe accidents in coal mines—accidents which maim and crush the bodies of individual miners. At intervals occur explosions or "cave-ins" which kill a number. It is an occupation of more than usual hazard: for even if the miner escapes death or injury by violence, he is likely to fall a victim to miner's asthma or some other disease of the respiratory organs engendered by breathing the damp and dust-filled atmosphere of the pit. And since many of the mines are remote from cities, it is necessary to employ a physician to remain constantly near



ONE OF THE HUGE BREAKERS.
In these buildings the freshly mined coal is picked over and sorted into various sizes.

MINE MULES TURNED OUT TO GRAZE APRIL 1, WHEN STRIKE BEGAN
These animals are stabled underground when the mines are working. Many of them had not seen daylight since the strike of 1902.

at hand. For the pay of such a physician the married men pay a regular fee of one dollar a month, and the unmarried half as much.

Each miner owns his own tools. They include not only pick and shovel, saw and axe, but drills and other apparatus for blasting. The cost and maintenance of his tools puts an additional burden of between $2 and $3 a month on each miner. The very lamp he wears on his cap will cost him—for wicks and oil—sixty cents a month. He must buy, also, the powder or other explosive he uses in making his blasts. That costs him as a rule $1.50 per keg of twenty-five pounds, and several kegs are used in each month. He pays also—speaking generally—a monthly due to cover the cost of a small insurance, and to his union the sum of fifty cents every thirty days.

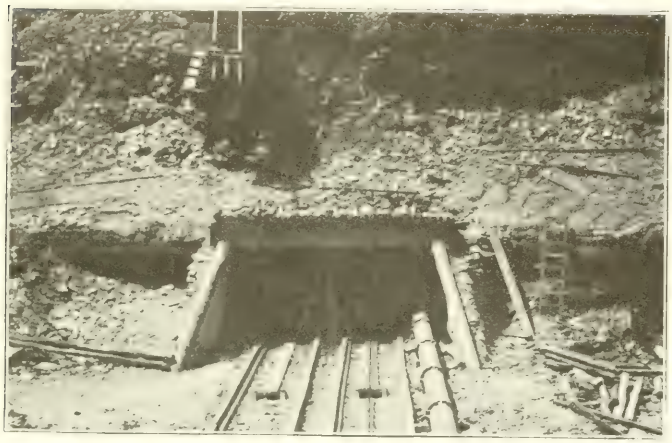
It is true that the rent of the houses—such as they are—is very small. A hut which will keep some of the rain off several people may be had as low as twenty-five cents a week. Some of the better class of miners — the English, Welsh, and Irish—live in much better quarters and pay as high as $8 a month rent. But they are becoming each month fewer in number, driven out by a horde of Slavs, who come each year to the mining country in increasing numbers, and who live in swarming and filthy huts, spending for food as little as $5 a month. At the present time it is estimated that there are considerably more than 100,000 Slavs in the anthracite country.

These make up the great majority of the workers in the anthracite region. And, from the standpoint of union labor, it is, perhaps, the greatest triumph of John Mitchell's life that he has been able to organize such an ignorant horde into a union which presents almost a

PENNSYLVANIA STATE POLICE AT WILKESBARRE.
Troop commanded by Captain Page. This constabulary was specially created for service in the anthracite region during strikes.

CLUSTER OF MINERS' HOMES AT WILKESBARRE, PA.

united front to the coal-owning railroads. To the student of social conditions, the figures in this connection are interesting. Before the strike of 1900, less than fifteen per cent of all the men and boys employed at the coal mines belonged to the Mine-Workers' Union. But when Mitchell issued his call, more than 85 per cent of the total number laid down their tools. Thirty days before the great strike of 1902, the union leaders could count but 65 per cent of the workers in their ranks. When the fight came, ninety-five per cent went out at the drop of the hat, and stayed out until the final award was paid.



ENTRANCE TO A COAL MINE.

Within twelve months of the settlement of the strike of 1902, nearly 75,000 members of the Mine-Workers' Union allowed their membership to lapse by non-payment of dues. But they can practically all be depended upon, to follow the command of the union leaders in an emergency. Selfish self-interest—if nothing else—has taught them that a successful strike means larger wages and shorter hours of work. In that way, if in no other, these Huns and Slavs are slowly—very slowly—being educated up to American standards of living and of labor. And the public—the great patient public—pays the bills. The anthracite-owning coal railroads have, it is estimated, more than 10,000,000 tons of anthracite coal piled up alongside their tracks in the vicinity of the city of New York alone. It will be some months before these great corporations will begin to feel any severe strain.

But the public pays!

What Uncle Ben Saw on a Kansas Farm

by

Ray Allen Billy

"MARTHA, Henry wants me to come out and see him this summer," said Uncle Ben as he took off his spectacles and folded up the letter. "He says us folks down here have only garden patches alongside of the Western farms."

"I don't know as to that, Benjamin, but those thousand-acre places must certainly be big. Why, one would reach from the Corners way to Jenkins's corn-lot on the creek, wouldn't it?"

"That, and more too. But I don't believe them Kansas folks are such great farmers. They may spread over lots of ground and not get so much out of it. If they can beat York State in growin' wheat and corn, they'll do well. Henry says they use steam engines out there for plowin'. Well, I guess our old team will do us for a spell yit. I believe, though, I will go out and see the boy. I haven't had a loafin' spell now for ten years, and I'd kind o' like to know how them Westerners do things, anyway."

And this is how it was that, a few weeks later, Uncle Ben alighted from the train and set foot for the first time on Kansas soil. As he was hustled off to Henry's farm behind the pair of sleek-coated bays, the old man had time to glance at the neat runabout, then at the well-groomed young fellow beside him. Henry not only wore a collar and neck-tie, but had his coat on. Nor were his trousers stuck in his boot-tops. "'Pears to me you're not workin' very hard, Henry, but things look prosperous," observed the old man, with a sidelong glance.

"I don't, Uncle—with my hands. We do more farming with our brains out here, because we have to. But everything you see is paid for, and there's no mortgage on the place, either."

"How many acres did you say you had?"

"About a thousand."

"Whew! That would make ten of the old place. S'pose you got most of it in wheat?"

"This year we have about 800 acres. You see, I raise some hay—about fifty acres. Then there's a hundred-acre corn-lot; and the rest is for pasture, a bit of a garden, and an orchard of as fine apple-trees as you ever saw in York State, I'll bet."

"A corn-lot as big as all my land. Well! Well! Don't see how you can do it."

"I'll take you around with me and let you find out for yourself."

The next day Uncle Ben was up bright

and early. He expected to see Henry in his farm "togs" this morning, but the young man looked just as spick and span as yesterday. He had merely put on a pair of heavier shoes and turned up the bottoms of his trousers. First, they went to see a field which was to be planted for a late crop.

"What's the fellow drivin' that wagon over it for?"

"That's not a wagon—that is a manure spreader. Instead of scattering it with a pitchfork as he goes along over the field, the man lets the manure scatter itself. As the horses move ahead, the stuff keeps working back upon a sort of drum or cylinder that revolves. The drum scatters it just as evenly as you shake the salt out of the salt-cellar."

"Hum. Saves time, don't it."

"Should say it did. That machine does as much as a dozen men could do, and does it better. But wait until we get down to where they are cutting corn."

Then Uncle Ben did whistle in earnest. Here were machines moving along the edge of the great cornfield just like the horse mower he used in his wheat patch. Projecting from the lower part of each was a long steel blade, which cut off every stalk just above the roots. As fast as each was cut, it was wrapped into a big bundle by a metallic arm which guided a cord around the stalks, tying the bundle mechanically. This contrivance was actuated by a crank which the operator could turn with his right hand, while controlling his horses with the other.

"Great thing, ain't it?" said the young farmer. "Cuts the corn and shocks it—all by horse power. Saves all the work we had to do with the corn knife. How my back used to ache when you were showing me how to shock on the old place! This is why a man can have a hundred or a thousand acres in corn out here."

"But it must be a job to husk it. Where can you get enough people to do it?"

Henry laughed. "You're thinking of the old-time husking bee and the red ear and pretty girl. Well, I'm sorry to say we're too new-fangled for that. Our husking bees are all run by steam power. We're going over to one of the corn barns now, and I'll show it to you."

Beside the door of the barn, was a curious-looking contrivance mounted on wheels, so that it could be moved from place to place like a wagon. From the front end, a pipe about the diameter of a heat pipe used in connection with the ordinary furnace projected into the barn-loft. From the side extended a wooden trough in which an endless belt revolved. On the other side of the machine stood a wagon loaded with cornstalks just as harvested in the field. A man with a pitchfork was piling these upon the me-

EVEN THE MANURE IS SPREAD BY MACHINERY.

tallic table of the husker, from which they were pushed into a hopper. Here the stalks were forced over knives which not only cut off the ears, but stripped the husks from each ear. As fast as the stalks and husks were removed, they passed to the mouth of the pipe running into the barn-loft, and were blown through it by a revolving fan. The ears fell into another hopper, where the kernels were shelled from each and poured into a bag at the side of the machine, the empty cobs being carried off by the endless conveyor in the wooden trough. A steam engine of about ten horse-power was belted to the sheller and husker, and operated it so rapidly that the two human feeders were continually at work.

"That's the sort of husking bee we have in Kansas," said Henry. "That machine does more than sixty people could do, yet it requires only an engineer and two men to feed it. You know now why Kansas has a corn-lot of over eight million acres, besides beating the rest of this great country of ours on wheat."

"You folks are certainly up to the times when it comes to corn growin', but I expect you have some big machines for wheat, too, don't you?"

"We'll have to put in a whole day where they're harvesting to show you that. One of my fields runs up against Charlie Sheldon's; but his is much bigger, and he uses what we call 'tractors.' My work is done by horse power."

"How do you tell where your wheat begins and his leaves off? I don't see any fences."

"Haven't had time to put 'em up yet. Too busy with the crops. But we fixed that. We just had each field surveyed, and we go by the stakes when we harvest."

"My, but they must be great patches."

"One of Sheldon's is two miles in a straight line from one end to the other."

The next day, when they reached the scene of operations in the wheat field, the spectacle was one which made Uncle Ben gasp with astonishment. He counted the horses hitched to the ponderous apparatus that loomed up in the sea of waving grain. Ten, twenty—actually thirty-two—in the string. Apparently they were pulling a threshing machine with a reaper attached to its side; but where the field had been covered the stalks were still standing!

Cutting Corn by Horse Power, and Shocking It at the Same Time by Machinery.

"That don't seem to cut very well," said the old man. "Must be a lot of waste."

"It's different from the harvesters you have East. Sometimes we leave the straw in the field if we are in a hurry, and just run a header over it; for if we want the straw, we can cut the stalks any time. What you see is a heading and threshing outfit. The header is just what it is called. It clips off the heads or tops containing the kernels. As fast as cut, they fall onto a moving belt, which carries them right into the thresher. As the thresher moves along, it threshes out the grain in the usual way and pours it into bags, so that all we have to do is to load the bags on wagons and take them right to the grain barn or to town. Just now, you know, wheat is up, and everybody is rushing it to market as fast as possible, so I am heading and threshing this

HARVESTING WHEAT ON A HILLSIDE BY MEANS OF MODERN MACHINERY.

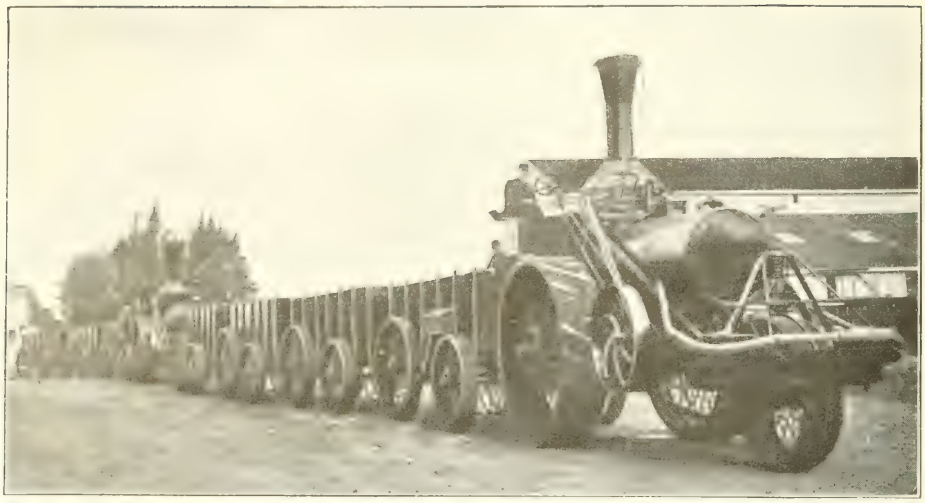
whole field at one operation. We can easily go over 50 to 75 acres a day with this outfit, for the header cuts a swath twenty feet wide. Over there, Sheldon is just running a header alone. You see, it is pushed along with four or five horses behind it. The row of wagons are 'grain barges,' as we call them. One is kept at the side of the header, and driven at the same speed. The heads are loaded into it by the moving belt; and, as soon as filled, it is driven away and another takes its place. He's got a stationary thresher somewhere, and the barges are feeding it; but wait till you see his tractor. I guess he's got it on the other side of the field. We'll get over there this afternoon."

When Uncle Ben saw it, he could scarcely believe his eyes. He knew all about the threshing machine, and the way it was drawn from farm to farm in York State, to separate the grain from the straw; but the traction engine merely pulled the thresher along the "pike," and then was used as a stationary engine to run the thresher. It seemed like a toy contrasted with this great farm motor, which moved across the field exerting the power of seventy-five horses; but the power was needed, for, as it worked its way forward, it kept in motion mechanism which cut every stalk of grain in a space thirty feet wide, carried it to the thresher, separated the wheat and put it into sacks, and then piled the straw to one side. Every twelve hours it converted 150 acres into stubble; yet the "crew" required consisted merely of an engineer and helper, a man to take away the filled grain-bags, and a fourth to control the movements of the thresher.

STACKING HAY WITH PATENT HAY LIFTER

"I wish you could see the tractor do the work of the farm horse in the early season," observed Henry, as he noted Uncle Ben's interest in the harvesting scene. "Here it takes just as many horses to turn up corn land as it does the clay soil out East. We would calculate about three to a plow, and to get over an acre or two is a good day's work, but it is wonderful what can be done with these things. When the

A MECHANICAL MAUD MULLER.
Rakes hay and stacks it at the same time.



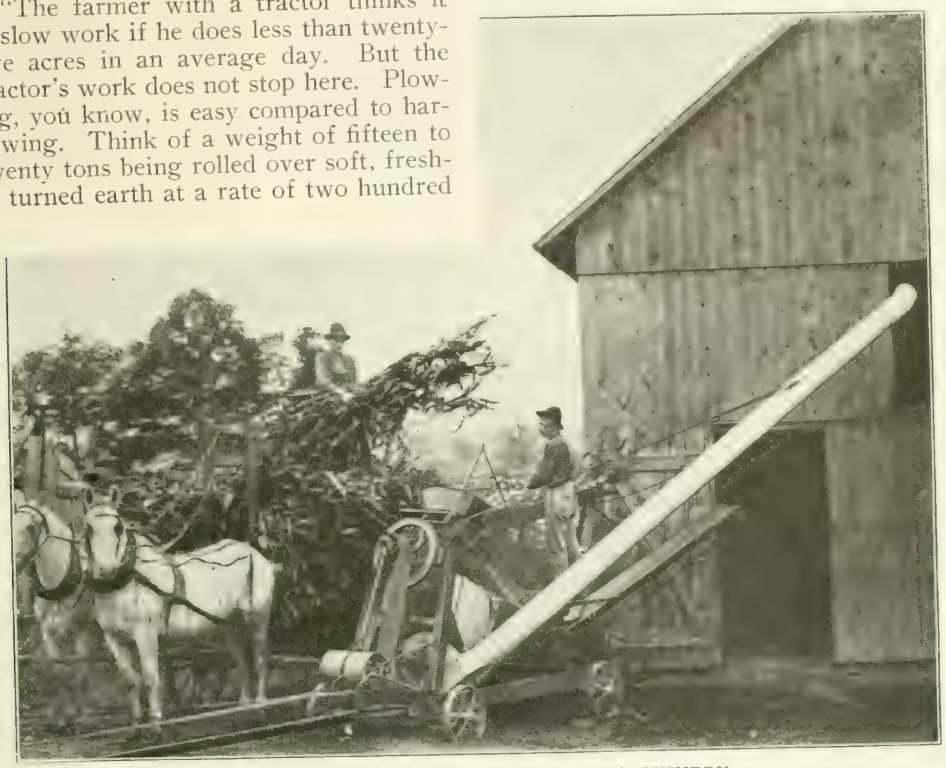
A FARM FREIGHTING OUTFIT IN THE WEST.
Hauled by two tractors, and used in the hill country.

tractor begins operations, there is no 'clucking,' no urging, no cracking of the whip. The engineer pulls his lever, and then, with both hands to the wheel, increases or decreases the steam pressure. Very slowly the great driving-wheels revolve at first, until the man gets an idea of the resistance from the stiffness of the soil. If he puts on too much steam, he may jerk the plows out of the ground and drag them along the surface. As it is, the big chunks of steel are thrown several feet into the air if they happen to get into a bed of loose earth or sand that the engineer did not notice. By degrees the whole surface is turned. Faster and faster the plow-points move through the earth and stubble, each cutting a straight

DIGGING POTATOES BY MACHINERY.
Alternate rows are first dug and picked up; then the others are dug. Otherwise too many potatoes would be tramped upon by the horses or covered over with dirt.

furrow. A strip from ten to twelve feet wide is plowed as the tractor moves across the field. There may be obstacles in the way—hummocks and stumps and stone piles. The steersman guides the big front wheel around them. Of course the plows cannot be steered; so, when one reaches the stump or stone pile, the tractor stops until the implement is lifted around it."

"The farmer with a tractor thinks it is slow work if he does less than twenty-five acres in an average day. But the tractor's work does not stop here. Plowing, you know, is easy compared to harrowing. Think of a weight of fifteen to twenty tons being rolled over soft, freshly turned earth at a rate of two hundred and fifty acres in a day. The tractor goes over ground so soft that the men walking beside it sink above their ankles in the loam or mud. The harrows it pulls are made specially for it. They are usually fifty feet square, ten times the ordinary horse size; and two or three are operated at a time, each covering two hundred square feet of ground, into which their teeth go to a depth of six inches. Yet they are dragged over twenty and twenty-five acres in an hour. Seed drills may be attached to the harrows, so that at one process the hundred-acre lot is planted and cultivated."



HUSKING AND SHELLING CORN BY MACHINERY.
The machine cuts the ears from the stalks, husks them, shells the corn, and carries the stalks and husks into the loft.

But even Western hay-making was a revelation to the York State farmer. He was accustomed to horse mower and rake; but the idea of loading the hay by machinery was something novel, and at his request Henry drove behind one of the automatic loaders. It was hitched to the rear end of the hay wagon, and consisted merely of a two-wheeled truck supporting an inclined platform, the lower part of which consisted of an endless belt. As the truck was drawn along behind the wagon, the hay was caught on the moving belt and carried up the incline to the top of the load, where it was stowed away by a man with a pitchfork. As fast as a wagon was loaded, the loader was disconnected and the hay carried to the barn or stack.

"Well, Henry, it's a great arrangement —somethin' I never cal'lated on—this farmin' by machinery. I see now why you folks out here on the prairies laugh at our little places. A hundred acres ain't even big enough for one crop for

POTATO-PLANTING MACHINE AT WORK.

No machine has yet been invented which will cut potatoes so that an "eye" will surely remain on each piece; but, once cut by hand, this machine will drop them and cover them up with earth

you, is it? But it must cost a pile o' money to buy these engines and headers and spreaders and what not, yet you say your place ain't mortgaged. How is it about your neighbors—that fellow who is the steam farmer—is he doin' well?"

"I should say he was. The last year we had sixty-cent wheat, how much do you think he raised—80,000 bushels. He had 4,000 acres and it cost him for everything from plowing to teaming it to the depot just $19,000 by his books. He really got $50,000 for the crop. Take out $20,000, and you have his profit—$30,000, and on sixty-cent wheat. Last year, you know, it touched a dollar. Well, he got in 20,000 bushels at that price out of a 60,000-bushel crop. The rest averaged 75 cents. Do you think he is doing well?"

'Well? Why, I'd like to sell my whole place for a quarter of his profit."

"What would you do?"

"Come out here and get rich, too, just like you fellows are doin'."

A Wish

IF any little word of ours
  Can make one life the brighter;
If any little song of ours
  Can make one heart the lighter—
God help us speak that little word,
  And take our bit of singing,
And drop it in some lonely vale
  To set the echoes ringing!

Power at Half Present Cost

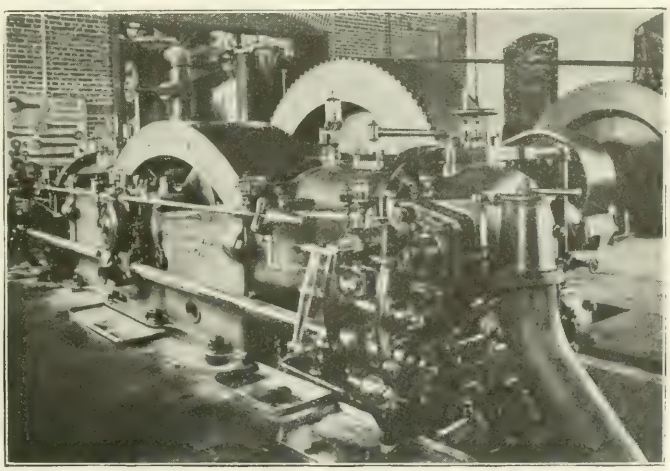
By Crittenden Marriott

IF some one were to discover that ordinary dirt was a fuel, which, burned under certain simple conditions, yielded as good or better results than the best Pennsylvania anthracite, it is easy to imagine the popular sensation that would be caused. Yet results almost if not quite as sensational, obtained by the U. S. Geological Survey Coal-Testing Plant at the St. Louis Exposition last summer, have passed almost unnoticed by the general public.

The experiments at this plant have demonstrated that bituminous coal, heretofore considered less than half as valuable as anthracite, will, when manufactured into gas and burned in a gas engine, produce as much net horse-power per ton of fuel as the best anthracite; and, still better, that lignite, which is so common all through the West and has been considered almost worthless, will actually yield more horse-power per ton than the best anthracite burned under a steam boiler. It has shown that all grades of coal, from the best to the most worthless as judged by former standards, can be utilized in this manner, their value for producing gas being, generally speaking, exactly inverse to their value in directly producing steam in a boiler. That is to say, the poorer the coal for direct steam-producing purposes (by which power coal has been valued in the past), the more valuable it seems to be for yielding gas for use in the gas engine.

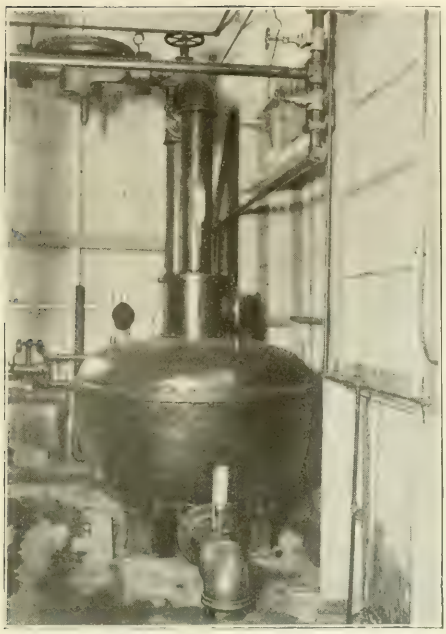
Considered simply on their merits, without comparison with anthracite, the lignites and bituminous coals tested yield two and a-half times as much power when used in the gas engine as they do when used under boilers for producing steam, and thus are shown to be available for fuel where before many of them were practically useless.

The value of the results of these investigations is, of course, not limited to the coal-producing sections of the country, but extends through every State and Territory where coal or other mineral fuel is used as a source of power. If coal can be made to yield two and one-half times as much power as it has heretofore, it means that only two-fifths as much coal will be required to produce a given amount of power. That is, our coal bills will be cut in half, although, paradoxically, the price of coal will not be reduced. For instance, in the New England States, where no coal is mined, the annual cost of the coal consumed for producing steam power for manufacturing purposes is approximately $50,000,000. The development of this power through the more efficient methods sug-



ENGINE AND PRODUCER ROOM OF SUCTION PRODUCER-GAS POWER PLANT.

GOVERNMENT PLANT FOR TESTING VALUE OF DIFFERENT COALS.
Results here attained may revolutionize power production.



A Gas Meter in a Producer-Gas Plant.

gested by these investigations would mean a saving to the manufacturers in these States of $15,000,000 to $20,000,000 per annum. And so in other sections of the country.

As another illustration of the way the discoveries at St. Louis may influence the affairs of the nation as a whole, it may be stated that there were used in the naval vessels of the United States in 1903 approximately 500,000 tons of coal, costing $2,500,000. If the future gas producer and gas engine can be substituted on our battleships and cruisers for the existing steam boilers and engines, the saving in the cost of coal would be not less than $1,000,000 per annum; and —which would be of far greater importance—the distance traversed by each ship without coaling would be more than doubled. Again, coals and other mineral fuels used in the United States cost the consumers approximately $1,500,000,000 annually; this means that the gas-engine method will reduce the consumption of coal sufficiently to save $500,000,000 a year to the country as a whole. It would seem incredible were it not vouched for by the government experts.

All the above, be it remembered, is with the gas engine of to-day, imperfect as it still is. But, as is well known, the gas engine is passing through a transitional perior. In the larger sizes, the vertical, single-acting engine is being replaced by the horizontal, double-acting. Other changes and improvements are constantly being made which tend to do for the gas engine what compounding and tripling the expansions have already done for the steam engine. When this is accomplished, the revolution in our ideas concerning the relative values of coals must be even more pronounced.

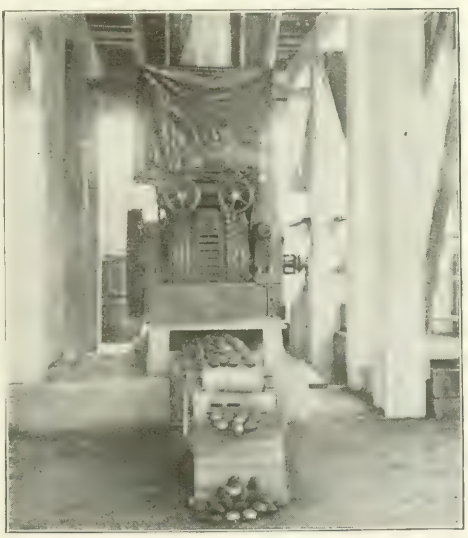
The authority for conducting the investigation whose results have proved so sensational, was contained in the Urgent Deficiency bill that passed Congress February 18, 1904. It read as follows:

"For analyzing and testing at the Louisiana Purchase Exposition the coals and lignites of the United States, in order to determine their fuel values and the most economic method for their utilization for different purposes, under the supervision of the Director of the United States Geological Survey, thirty thousand dollars, to be available until expended.

Provided, That all testing machinery, and all coals and lignites to be tested, shall be contributed without charge to the Government,"

Two months later, in the General Deficiency bill, an additional appropriation of $30,000 was provided, making the total sum appropriated for the purpose $60,000—enough to carry on the work till July 1, 1906.

For carrying out the provisions of



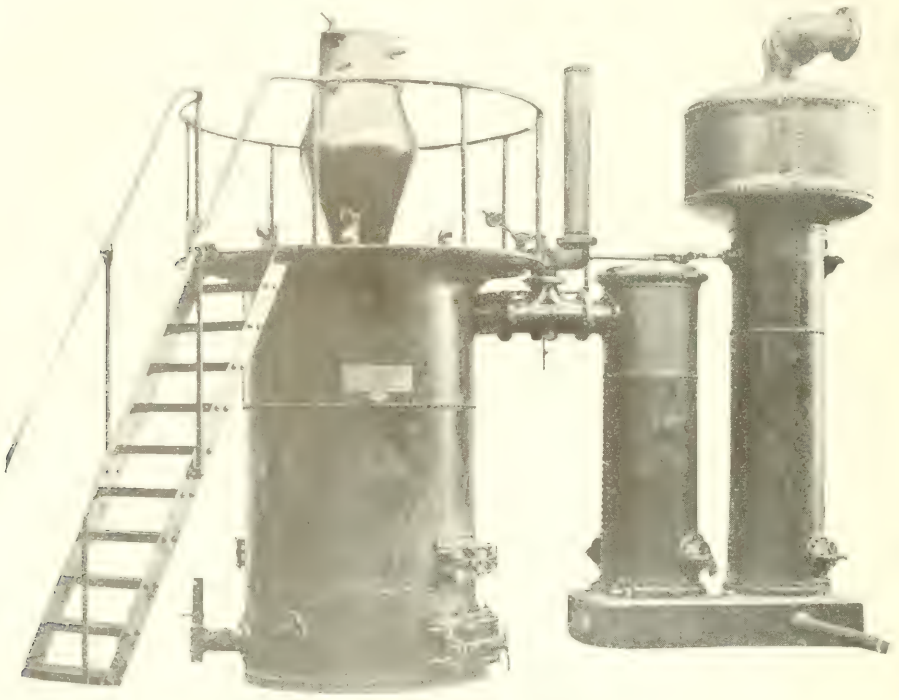
American Briquetting Machine at Work.

these acts, the Director of the Geological Survey appointed a committee, consisting of Edward W. Parker, chairman, Joseph A. Holmes, and Marius R. Campbell, to direct the construction and operation of the plant.

As the law required all the testing machinery and all the coals that were to be tested to be furnished to the Government free of charge, it was not possible to equip an ideal testing plant, and the assembling and construction of such equipment as could be obtained entailed some annoying delays; but the plant was finally put into working order.

Next came the selection of the samples. Under the terms of the law, all these had to be furnished free and delivered free. It was decided by the committee in charge, that, for practical tests of the character contemplated, not less than one carload of coal should be accepted. In response to invitation, offers of coal were made from almost every coal-producing State in the Union. From these offers it was decided to accept such samples as best represented the State from which they were obtained, and also, as far as possible, the various fields or districts within the State.

The value of tests of fuel and similar materials depends largely upon the way in which the samples are obtained and what they represent. Accordingly it was decided that the Government should superintend the collection of the samples, so as to be in position to guarantee that the coal tested fairly represented the commercial product from the mine—so far, at least, as one carload can represent the average output.



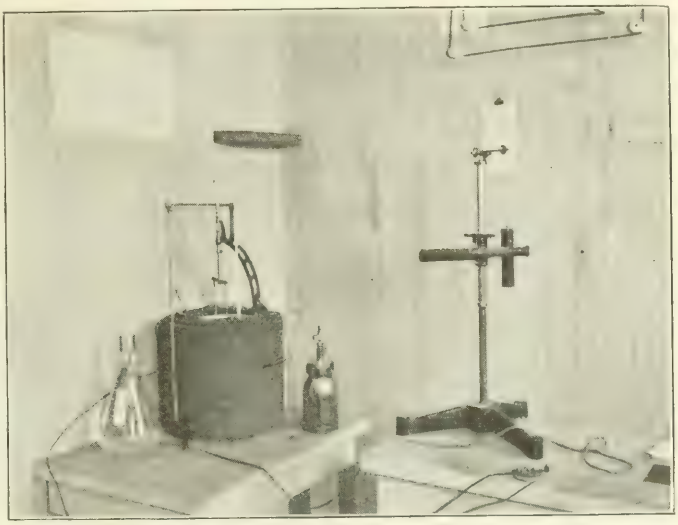
AMERICAN CROSSLEY SUCTION GAS-PRODUCER.

In order that a car shall contain average coal, it must be loaded with coal from all parts of the mine. This could be done only by setting aside cars for different rooms until coal from all rooms had been obtained. This, however, was impracticable, as it would require a great many mine cars and more trackage than almost any mine possesses. But, in the course of regular work, coal comes from all parts of the mine; and therefore, in a mine of small or medium capacity, a car loaded in the ordinary manner is

likely to contain coal from all parts, and therefore to be representative coal. The sample was therefore collected as it came from the mine, being carefully watched so as to prevent any irregularity that would tend to make the test sample better or worse than the average output. It was on these samples that the sensational tests were made.

Another demonstration not so sensational but almost as important, relates to the use of slack or waste. It has been shown that this will make good gas also. Every coal mine is surrounded by enormous piles of slack which will burn but will not bring enough in the market to pay for transportation for use beneath boilers. However, by placing it in a gas producer, this slack will drive an engine with an economy of four times that obtained by burning it under a boiler, and for such use can pay any reasonable freight. This discovery is worth millions of dollars, transforming as it does worthless mountains of slack into valuable fuel. As about half the output of every bituminous mine is slack, the value of this discovery may be guessed.

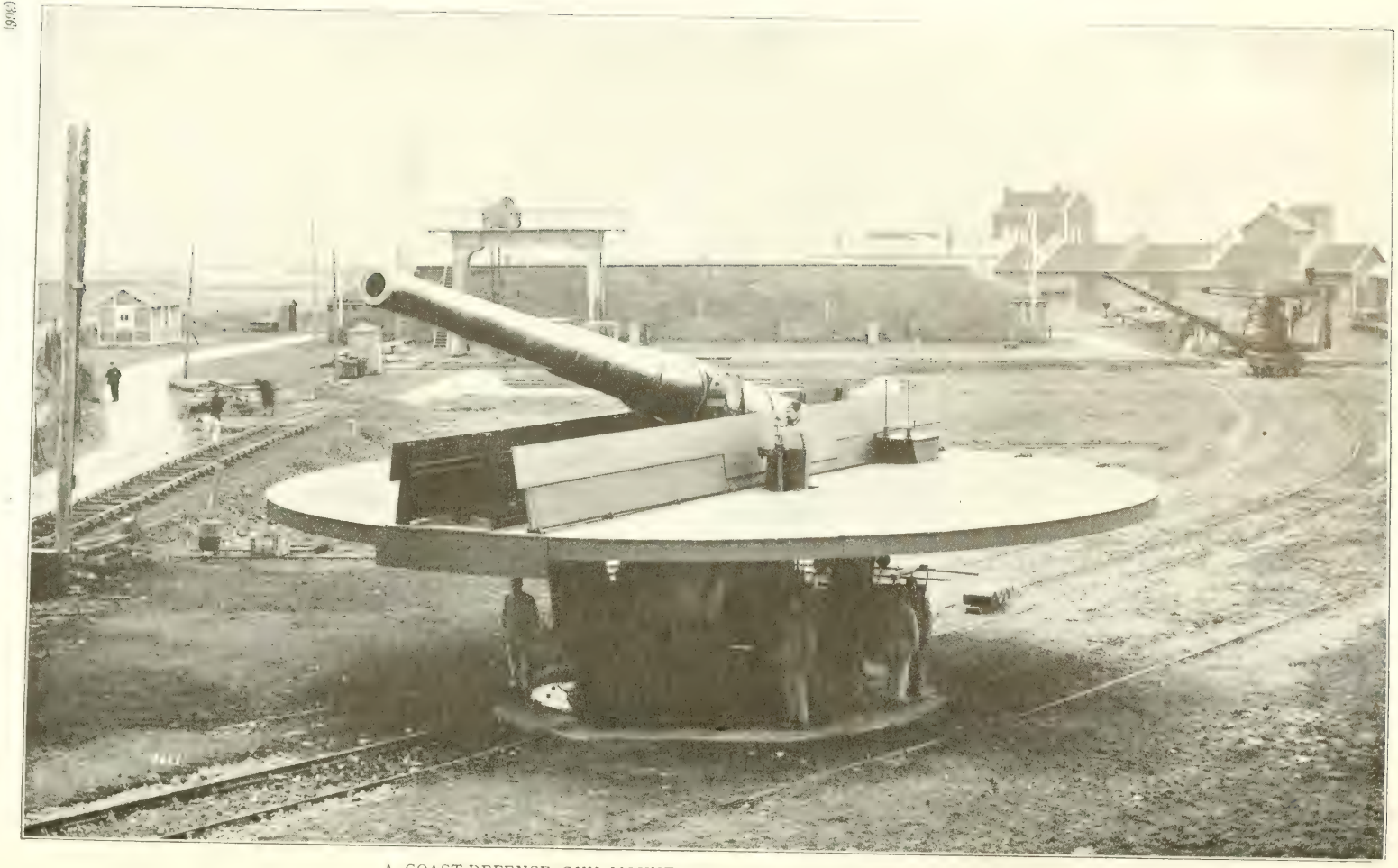
Still another demonstration at the plant relates to briquettes. These, which have long been used in Europe, consist of waste coal mixed with some binding material compressed into "eggettes." They are used abroad for cooking, house-heating, locomotive-driving, and for furnishing steam power generally. This form of fuel is very important in countries where coal is scarce, and we are approaching the necessity for using it in several parts of the United States. The cost is the main factor here, as on it depends the power of briquettes to compete with coal. The coal-testing plant has shown that in certain parts of the country, where both lignite (or bituminous coal) and an efficient binder are found in close proximity, they can be made and shipped for considerable distances at a good profit. Briquettes properly made make no smoke, and have been found to be considerably more economical and much cleaner than coal.



CALORIMETER AND READING TELESCOPE.

Worth Listening To.

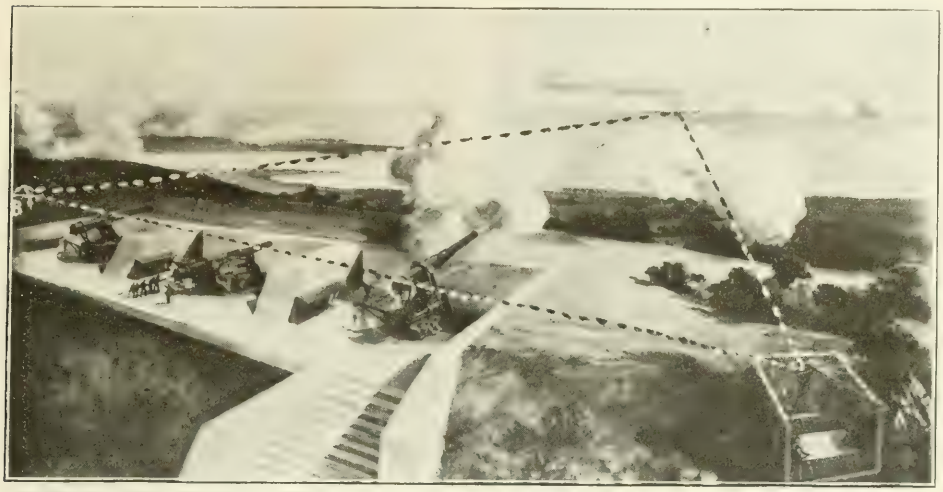
A MAN rather taciturn in speech; silent when there was nothing to be said; but pertinent, wise, sincere, when he did speak; always throwing light on the matter. This is the only sort of speech *worth* speaking.—CARLYLE.



A COAST-DEFENSE GUN MOUNTED ON DISAPPEARING-GUN CARRIAGE.

A MODERN FORT IN ACTION.

Mortar battery shown in foreground at left; fire-control station at right. Rapid-fire guns are located along water-front. Dotted line shows imaginary triangle.



FROM DRAWING BY H. A. SHAFER. COURTESY OF "N. Y. HERALD."

War a Matter of Mathematics

By M. C. Sullivan

NEVER again will a Farragut "damn the torpedoes" and lead his fleet past the guns of a land fort. Never will a Dewey—no matter how brave—take his battleships into the harbor of a hostile city. Modern seacoast fortifications, in the opinion of all experts, cannot be successfully assailed from the water side.

In the manning and operation of these impregnable fortresses, calculating science and electrical apparatus have taken the place of individual daring and keen human eyes. Where, of old, the gunner raised or lowered his great weapon into place, and, carefully sighting along its barrel, aimed it at the approaching foe, the gunner of to-day, seated far down underground, behind and below heavy earthworks, pulls a few levers which elevate or depress his gun and give it proper direction, and then starts the mechanism which lifts the concealed weapon above the top of the parapet. The instant it comes to rest, it is automatically discharged, and the recoil sends the gun back to its covered resting-place, out of sight and fully protected from the enemy's shots.

Rarely does the modern pointer of a great coast-defense gun see the target at which he aims. Rarely can he note the effect of his fire. Instead of listening to the hoarse cheers of his comrades in the trenches, his ears are strained to catch the whispers which come over the telephone receiver fastened to his ear from the commander of the gun crew, who is stationed at the distant range-finding and fire-control station.

Most of the glory is gone from war—at least from this part of it. It has become a matter of mathematics and mechanism. Instead of calling for the heroic devotion of brave men, risking life in defense of a forlorn hope, it needs now the careful calculation of college professors and the technical skill of electricians and mechanics, both working under conditions of small personal danger.

Very new and modern are these almost

THE PLOTTING BOARD IN USE.

automatic and entirely impregnable coast-defense forts. So modern, indeed, that the installation of comparatively few of them has been completed. But so complete is the confidence of all the experts in their inviolability, that $50,000,000 is to be spent at once by the United States alone in the perfection of its coast defense. Of this amount, at least one million will be expended at Forts Hamilton and Schuyler, guarding the harbor of New York.

In coast-defense work the first necessity is to be always prepared for attack—never to be caught napping. With this idea in view, small ships of a new type and great speed are being built for scouting purposes. Telephone systems, supplementing the telegraph, are being built along the whole coastline, each station connected with the nearest fortress. Coast guards and lookouts are being furnished with portable searchlights; and each observer will carry with him a portable telephone, the receiver clamped to his ear, so that he may be in constant touch with the officer in command of the fire-control station. More remarkable still is the flying "periscope," a scientific combination of telescope and camera, which will automatically take snapshots showing the details of everything visible on land and water within a distance of ten or even twenty miles.

In practice it has been found possible to locate a target five or six miles away, make the necessary calculations, aim and fire a gun, and drop a shot exactly on the specified spot, all within three or four minutes.

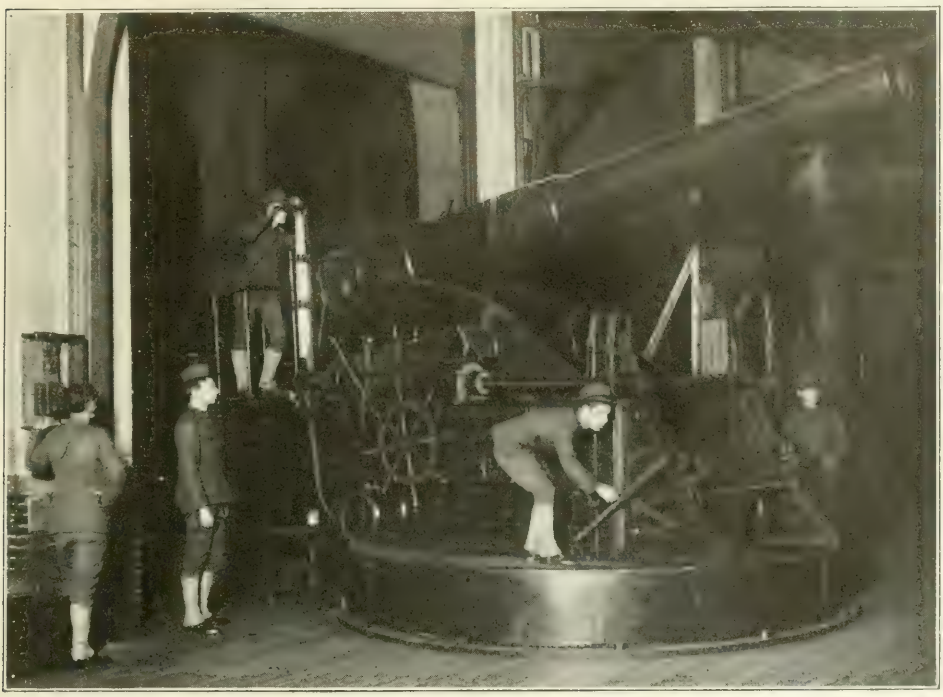
The general plan or layout by which the heavier guns and mortars are enabled to make such remarkable shots at extreme long range, may be better understood by reference to the illustration of the "horizontal base" system of range finding.

Within the fortification, there are two observation points, at which the range stations are located. In each are placed the mathematical instruments for sighting a hostile vessel, which is the possible target, and determining its angular direction. One of these is the fire-control station, which, like the conning tower of a battleship, is the nerve center of the fort. From it, to all parts of the fortifications, extend electric lines for communication purposes. The importance of these lines cannot be overestimated. In mere size, the nerves are far and away the slightest and most insignificant portions of the human anatomy. The greatest of these is as nothing compared with the least of the bones or muscles. But destroy these microscopic nerves, and the great bones and muscles become mere helpless, floundering, useless things, incapable of action, and a burden by reason

COAST GUARDS USING AZIMUTH TELESCOPE AND TELEPHONE.

of their very bulk. As are the nerves to the body, so are the electric wires to the modern fort.

As might be expected, there is little of the so-called glory of war in this kind of fighting. The men not only fight behind earthworks, but their work is of such a nature that there is practically no need of their being exposed at any time.



A MODERN DISAPPEARING GUN.

They are located in sunken trenches or emplacements so contrived that no shot can be fired at them which will hit them. The only possibility of a shot finding its way into these hiding-places, is in the event of a shell bursting overhead so that some part of it is thrown downward at an entirely different angle from the direction in which it has come. There is not one chance in hundreds that such a thing will ever happen, and by just that proportion is the safety of the men in the batteries secured.

The work laid out for the men in the range stations is so to read the positions of the enemy's ships that the guns may be aimed at them with mathematical accuracy. It may be well to mention here a few of the elements to be considered in such an undertaking. It is not enough to locate a ship at a given moment. Since the ship is constantly moving, her speed must be estimated, and the time it will take her to reach a certain point thus calculated. The velocity of the shot must also be considered, and the proper allowance made for the time it will take to reach the point selected. Then, again, the angle of the gun must be calculated according to the length of the range. In firing a shot a distance of several miles, it is necessary to elevate the muzzle of the gun much higher than for a shorter range. An entirely different set of calculations must be carried out for each type of gun. The mortars, for instance, since they must be aimed at a very much higher angle than the rifles, demand entirely different treatment. The density of the atmosphere and the force and direction of the wind must also be taken into consideration.

A gun is never fired directly at a moving ship. Should a shot be sent directly after a vessel going at speed, the target

SEARCHLIGHT LOCATED ON BEACH.
Connected by telephone with range-finding and fire-control station.

would be far out of the way long before the shot arrived. It is necessary to fire a shot at the supposed spot the vessel will occupy at the instant the ball reaches its destination. The gunner, therefore, literally fires into the air, but with the belief, based upon the most careful calculations, that the ship will arrive in time to be hit.

In the work of the mortar batteries it is necessary for the calculation to be even more accurate. The side of a warship presents a large target as compared with the deck of the same ship, which is the target of the mortar batteries. It is thus much more difficult to hit the deck; and yet so accurate are the observations and calculations of these modern gunners that it is generally believed no navy could successfully steal past a modern fort.

Let us now see just what happens when all this machinery is brought into play. The actual process is by no means as complicated as might at first seem. By following the position of the range stations and batteries in the illustration, the process will appear comparatively simple.

On the instant a hostile ship appears on the horizon, readings are taken at the two stations *A* and *B*, *A* being the fire-control station. An imaginary line drawn between *A* and *B* is called the "base line" for the operations which follow. It will be readily understood that, given the length of this base line, and the angles at which the vessel is observed, it is possible to construct a triangle, and the apex of this triangle is of course the exact position of the ship. Thus far the problem is a very simple affair of trigonometry.

It will be understood, of course, that at such a moment every second is valuable and there is not a moment to be lost in calculations.

To simplify this operation, station *A* is supplied with a large drawing board in a fixed position. On this board is a miniature chart, drawn to scale, of the waters it is intended to control. The base line or imaginary line from *A* to *B* is plotted on this board. Attached to the chart at the points corresponding to the two stations, are two steel arms swinging from pivots at points corresponding to *A* and *B*.

Now the problem of calculating the height of a triangle, given the base and the angle of the two sides, could be worked out in a few minutes with the aid of a book of logarithms. Imagine, however, the difficulty of looking up the necessary data and solving an equation, with the enemy approaching at full speed.

COAST GUARDS ON LOOKOUT.
In continuous telephone communication with the fortifications.

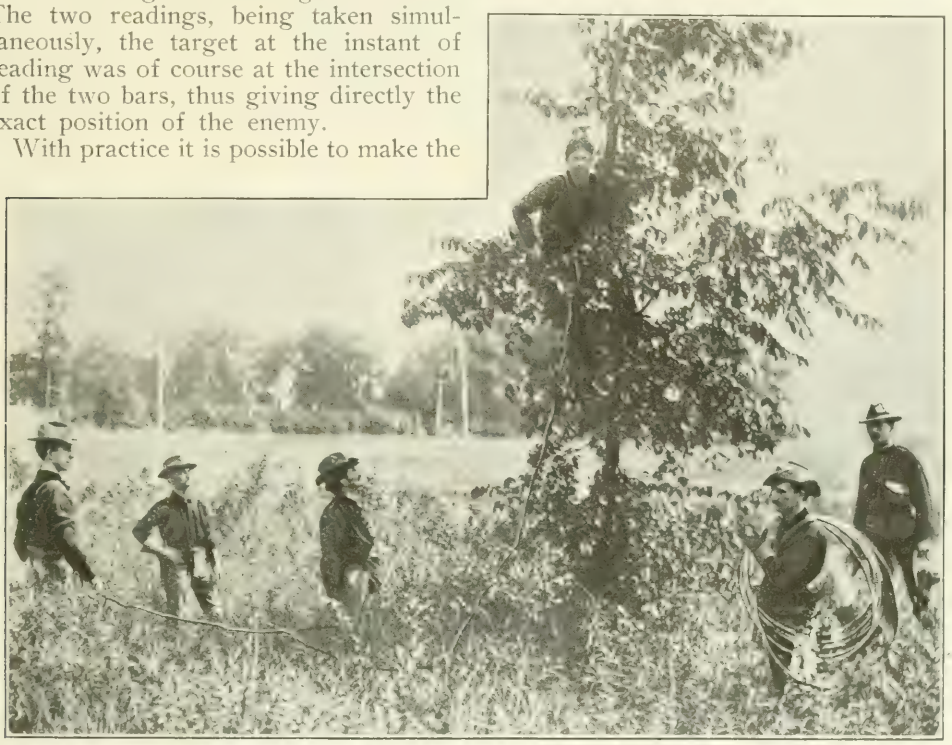
The plotting board enables the fire-control commander to solve the problem at a glance.

In actual practice, the instant the reading at station *A* is effected, a man stationed at the plotting board for the purpose, merely swings the *A* bar to the angle read off; and when the reading comes from station *B*, the second steel bar is swung to the angle indicated. The two readings, being taken simultaneously, the target at the instant of reading was of course at the intersection of the two bars, thus giving directly the exact position of the enemy.

With practice it is possible to make the readings, plot the triangle, and determine the position of the ship in a very few seconds. The height of this triangle, therefore, gives the exact range of the gun.

This operation is repeated every twenty seconds for one minute, three readings, therefore, being taken. These three readings serve to give the course of the vessel and its speed. At times, more readings are taken; but such is the accuracy of the work that three readings usually suffice. It is comparatively simple, given the distance the vessel travels in one minute, to calculate just how fast she is traveling. In addition to determining the speed of the vessel, these readings also indicate the course.

The three points on the plotting board will be sufficient, as a rule, for drawing the arc of a circle or a straight line which will indicate clearly what the vessel's course will be for the next few seconds. Should they not be sufficient, more readings may be taken.



BUILDING TELEPHONE LINES FOR MILITARY SERVICE.
Natural supports, such as small trees, are used for elevating the wires.

To the layman, the idea of plotting the exact position of a ship miles out at sea may appear a hit or miss affair and hopelessly inaccurate for firing purposes. But it must be remembered that the men in the forts know the harbors before them and are familiar with the movements of all ships in those waters. In all cases, again, the harbors can be entered only along regular channels; and should a ship in three readings appear to be moving along one of these channels, it is safe to count on her continuing.

In such a case the course of the ship for the next minute or half-minute can

be plotted with accuracy. Another point in favor of the fort is the rapidity with which the calculations are made. Suppose the enemy to be manœuvering in the open sea, it is impossible for the ship to alter her speed materially or change her course before she can be reached by a shot from one of the great guns of the fort.

Should the range-finders, for instance, determine that the enemy was traveling at the rate of seventeen knots an hour along a straight course, it would be known that she could not increase or decrease her speed, in the few seconds before the shot reached her, sufficiently to throw out the calculations. Then, again, if her course were known, and she were traveling at a known speed, the enemy would find it practically impossible to swerve to either side far enough to escape the shot.

Before the guns are ready to be aimed, another calculation remains to be made. A third arm on the plotting board determines what is to be the elevation of the guns, and the direction in which they are to be aimed. The velocity of the shot and the speed of the vessel being known, a direct reading chart shows how far ahead of the enemy the gun must be aimed in order that shot and ship will arrive at the same spot at the same instant.

The modern gunner of a great fort seldom sees the ship he is firing at. He usually is safe below an earthwork embankment which towers high above him, and he merely receives instructions and carries them out like an expert operator of an intricate machine. The men in these forts are not "men behind the guns" in the commonly understood meaning of that term. It is the men in the range-finding and fire-control stations who decide the issue of the great modern seacoast battles.

DISAPPEARING-GUN CARRIAGE CONTAINING A 27-CENTIMETER CALIBER 40 GUN INCLOSED WITHIN THE MOUNT.

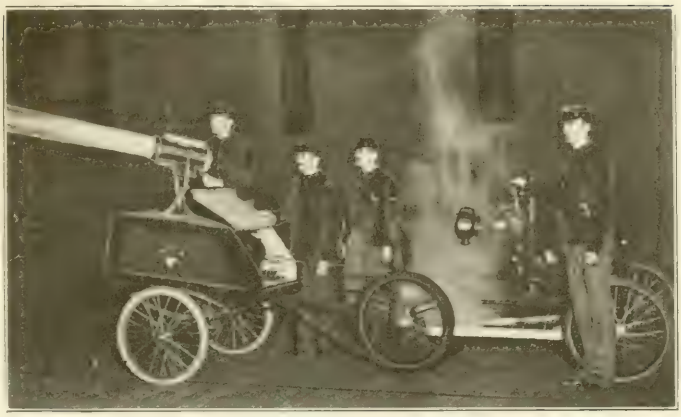
The success of the fort, the outcome of the engagement so far as the great batteries are concerned, is determined before a gun is touched. Everything depends on the accuracy of the men in the range stations. The position of the target, once determined, is telephoned to the officers at the guns. There are no hoarse-voiced orders. The range and direction are read off, and an instant later the men at the guns turn the great mechanisms to the proper angle and raise or lower them to the required elevation.

A few seconds, and these great engines of destruction are aimed to the fraction of a degree according to the

instructions telephoned by the firing master in his subterranean station.

At the appointed time, the guns are released, rise quickly until the mouths of the cannons are above the parapet, when they are instantly discharged. The force of recoil throws them back, and they fall once more smoothly into place.

The disappearing gun makes it practically impossible for an enemy to injure a fortress's weapons of offense.



PORTABLE SEARCHLIGHT.
Used for signaling at night from shore to scout boats.

One of the great advantages of the centralized method of range-finding and fire-control is that one gun, an entire battery, or a whole series of batteries containing scores of great guns may be firing as rapidly as they can be loaded, and each with a mathematical accuracy.

The power thus given to a single man is, of course, extraordinary. His skill may reap a victory never conceived in ancient warfare, while his mistakes may prove correspondingly disastrous.

The electrical control of the modern fort has worked a revolution in its operation, for it places every part of the fort in instant communication with every other part. And, since the wires are buried, the hottest and most persistent fire cannot isolate one part of the fort from any other. The question whether the element of martial bravery is fostered under such conditions, is an interesting one. The modern fort is manned by machinists and mathematicians. It is interesting to speculate how far this may have a tendency to abolish warfare.

The glamor of uncertainty and hope, and the charm of adventure have always been great factors in making war interesting to mankind. To those who observe modern conditions, it would seem that the ever-increasing scientific precision of war, which is rapidly diminishing the value of the personal factor, must make for universal peace. For the war spirit of all time past has been fostered by the hope of glory to be won through individual achievement, and not through a superior knowledge of scientific methods of indirect killing, as has now become necessary.

Chemist Takes Place of Cook

By LAWRENCE PERRY

SCIENTISTS move in mysterious ways and in divers places their wonders to perform. It may be a mile underground, tamping at the earth's substratum; or it may be a mile in the air, working magic with the writhing elements; or in quiet, pungent laboratory hours, evolving gold out of sea-water—evolving anything.

It remained with Prof. Thomas B. Stillman, M. Sc., Ph. D., a member of the Chemical Society of Paris, director of the chemical laboratory of the Stevens Institute of Technology, to carry his thaumaturgy to the dining room of a gilded hotel, entertaining two friends—favored of the gods—at a dinner the components of which, excepting the meats and cigars, were produced artificially by chemical combinations.

A "synthetic dinner," he called it; and if one of the spectators at the conclusion of the repast walked more or less rigidly to the bar of the Hotel Astor in New York City, and in stuttering accents called for a "real cocktail," this fact may not be held against Doctor Stillman—or his dinner, either—in face of the fact that each course was enjoyed in the eating, in the drinking thereof, and that the diners are still living and eating in undiminished health and gastronomic felicity.

The participants were likewise honored and brought to unexpected fame in having eaten, as was their host in having prepared, the first chemical dinner ever given in this civilized world. The prime object of the feast was to demonstrate the possibilities in the way of substitution of artificial, manufactured food for the natural article: to demonstrate also Doctor Stillman's contention that much food adulteration is not really harmful. The subject came up at a dinner given by the chemist at his club in New York to Henry W. Goodrich, a lawyer of that city, and to James E. Howell, a Newark, N. J., attorney. The two guests took violent and frequent exception to many of Doctor Stillman's dietary paradoxes, finally drawing from him a challenge the fruition of which has made the name of Stillman a byword in every laboratory of the habitable globe.

"Gentlemen," said the chemist, "to prove what I say, I stand ready to treat you to a dinner at which nothing will be genuine but the meat and lettuce and oysters. Further, to prove how harmless it all is, I will eat of every dish myself—if you will back me."

The challenge was accepted forthwith; and on the night of February 21 the two guests were seated with more or less equanimity at a table in a private dining room of the Hotel Astor. It was a remarkable dinner. In the small serving room, amid clouds of steam, pale flashes

of blue and red flame, subdued explosions and sizzlings and sputterings, Doctor Stillman, like another Merlin, brooded over his appliances, extracting from out of the confusion of alchemy, not portents of good and evil, but food palatable and for the most part wholesome. In one corner was a great glass retort arrangement, a German appliance, dropping a clear liquid into a glass (a cordial distilling); while in other corners and upon

MAKING A SYNTHETIC MARTINI COCKTAIL.

tables were jars and cups and beakers and tubes, all evolving results grateful alike to scientists and epicure. And this is what they ate:

Martini Cocktail.
Oyster Cocktail.
Sauterne.
Green Sea-Turtle Soup.
Biscuit.
Roast Ptarmigan, with Currant Jelly.
Raspberry Sherbet.
Mexican Pear Salad.
Vanila Ice-Cream.
Coffee
Crême de Menthe

The Martini cocktail which prefaced the evening's repast was no tossing together of vermouth and Tom gin. Doctor Stillman made it before the eyes of his guests—its constituents alcohol, saccharine (which is 600 per cent sweeter than sugar), absinthin, ice, and aniline yellow. Absinthin, being the essence of wormwood, produces the precise flavor of vermouth, and just a grain of saccharine gives the natural sweetness of the gin; *ergo*, a fine Martini cocktail—not the real thing, but tasting just like it, and imparting, as Doctor Stillman recently put it, "Oh, such a headache!"

The main element of the oyster cocktail was, of course, real mollusks, but the condiments were essentially synthetical. There was blend of citric acid to impart the lemon flavor; oil of capers (the horse-radish equivalent); capsicin (the active principle of cayenne pepper); artificial vinegar (of which the chemical formula is $C_2H_4O_2$-H_2O); and aniline red to impart to the symphony the beautiful red of the tomato.

There were no sun-mellowed grapes involved in the sauterne; the poetry of

the wine press, the vineyard songs, the barefooted toilers in picturesque attire working amid the sunlit hills—ponderings born of bouquet, ponderings as delightful to the *bon vivant* as the taste of the vintage—all were lacking in the production of Doctor Stillman's *haute sauterne*. Here, however, is what was not lacking—we translate the constituent parts from the French of the menu:

Malic acid, $H_2C_4H_4O_5$.
Tartar, $KHC_4H_4O_6$.
Alcohol, C_2H_6O.
Acetic ether, $C_2H_3O_2C_2H_5$.
Gluem, $C_5H_7N_1$.
Artificial quince essence, $C_4H_7(C_2H_5)O_2$.
Distilled water, H_2O.
Naphthol yellow S, $C_{10}H_6O_{10}$.

The green turtle soup was formed of aqueous turtle extract flavored by artificial sherry, salt (NaCl), and capsicin. For the biscuits, Doctor Stillman first made a synthetic starch over his alcohol lamp, thus getting his flour. He mixed his biscuits with the following formula:

Starch, $C_{36}H_{60}O_{30}$.
Tartar, $KHC_4H_4O_6$.
Distilled water, H_2O.
Saccharine, C_9H_4 CO. SO_2 NH.
Bicarb. of Soda, Na HCO_3.
Milk, composed of casein (95 per cent) and sodium glycero-phosphate (5 per cent), making sanatogen, which, mixed with cold water, looks and tastes like milk, but with no nutritive value.

The currant jelly accompanying the breast of ptarmigan never saw a currant, being composed entirely of chemicals. The Mexican pear salad was pronounced by Doctor Stillman to be his *chef d' œuvre*. He used the pear itself (time alone preventing the compounding of the fruit by alchemy), but all the other ingredients were artificial. There was egg made of protein, starch, fat, etc.; artificial sugar; vinegar; mustard oil (C_3H_5CSN); olive oil ($C_{18}H_{34}O_2$); and chlorophyl, this last being the active principle found in the coloring matter of plants, which gave the salad a refreshing green tinge. The sherbet had a delicious raspberry flavor, which required a very dainty adjustment of ethers to produce.

The vanilla ice-cream called for no confectioner. The alchemist simply took some triple refined cottonseed oil, placed it in a centrifugal machine which revolved at a velocity of 3,000 revolutions a minute. A beautiful emulsion was thereby produced, which was then frozen, chemically, of course. The flavor was obtained by the addition of vanillin, glucin, and nitro-benzol. They say that ice-cream composed as above is sold in many Southern States where cottonseed oil is more plentiful and consequently cheaper than milk or cream. It is far from harmful, tastes good, and does not melt as quickly as the genuine ice. The coffee was an extract of cereal coffee, produced by pouring hot water upon a mixture of ground chicory, wheat, peas, and one or two other cereals.

The *crême de menthe* which concluded the dinner was scientifically and æsthetically the *pièce de resistance* of the synthetic function. The diners, upon partaking of it, declared it superior to the genuine cordial, an admission which they withheld in the case of the sauterne, which, while being pronounced very good, was condemned as tasting just a little "new," youth being a crime only in the matter of wines and furniture. Doctor Stillman produced the green liqueur by distillation from a mixture of peppermint, balm sage, cinnamon, orris root, ginger, and alcohol, to which was added aniline green and sugar.

And thus was the dinner prepared; and as it was prepared, so it was eaten, without, as we have before observed, any untoward result.

The aftermath has dazzled Doctor Stillman, who proposed and concocted the dinner with no thought of the stir it would create. Day after day his mail is heavy with letters from eminent scientists the world over, inquiring first whether or not he still lives; and if so, will he please furnish them complete formulas of the courses; thanking him also for the presentation of a new field of endeavor to the world of science; urging him not to rest upon his gastronomic laurels, but to move onward along the path he has laid out to newer and higher gastronomic levels.

"I don't know about this last," said Doctor Stillman, discussing the dinner with the writer of this article, standing among his appliances in the laboratory of the Stevens Institute at Hoboken, recently. "I could go on, and I could evolve new courses; in fact, I think I could answer every call of the vegetarian.

The creation of meats gives me pause, though. Yet in Germany, word comes that chemists are transforming mineral oils into animal oils—this is a step forward in the line of creating artificially the food elements in animal substance without their having undergone the processes

furore his dinner has aroused, and his eyes sparkled with all the potency of some of his most alluring chemicals as he discussed it. There is nothing of the musty gruff scientist about him; he is well-groomed, debonair, and ruddy with health and good spirits.

"FOOD CORNER" OF DOCTOR STILLMAN'S LABORATORY.

of life. But as it is now, we cannot in any way reproduce the fibers or the proteids, the chief nutritive constituent of meats. Chemistry can, however, produce from its crystals and fluids a fine dish of mashed potatoes. With this as a basis, we could compound an imitation corned-beef hash, which would appease the eye of the meat eater if not his appetite."

Doctor Stillman thoroughly enjoys the

"No," he said, smiling, in answer to a query, "it would be a very difficult matter for me to starve to death in this laboratory, unless, indeed, hands and brain were paralyzed," and he glanced fondly at the apparent jumble of bottles and crucibles and alembics and other things surrounding him on all sides. Then, lest the visitor might leave with a confusion of ideas—not improbable—he went on to

explain that the material from which nature works her wonders in the growing of foods is the chemical elements. Like nature, the chemist works with these elements also. There are seventy of them—all metals, with the exception of the potent seventeen elements known as "non-metallic (oxygen, hydrogen, carbon, etc.). Working thus, the chemist can make an egg omelet that would deceive a chef. He can also present you with a banana made from a jar of chemicals, simply by analyzing the constituents of the banana and combining these artificially. This, by the way, was the secret of the synthetic dinner as it was explained by Doctor Stillman.

PROFESSOR STILLMAN IN HIS LABORATORY.

"By analyzing foods and drinks," he said, "I found the chemical elements which nature had used in making them. Then I simply reverse the process in my laboratory—jumping from analysis to synthesis—and created the foods and drinks from their chemical constituents. There is really nothing new in what I did, and yet the requests for formulas which I am receiving every day might lead one to think so. It may be that a synthetic dinner of successive courses, such as mine was, was an innovation—it may be that; but I know that many of my profession have been experimenting with the synthetic food problem for many years. The bad chemists have caused all the trouble about food adulteration; the good chemists are applying their efforts to the detection of frauds thus created."

In explaining his very potent cocktail, which did many wonderful things the night of the dinner, Doctor Stillman held up a small bottle, no bigger than a thimble, marked "Absinthin," containing about a teaspoonful of light brown powder.

"This powder," he said, "was obtained from twenty-five pounds of wormwood, and its commercial value is sixty cents a gram. The powder, small as the amount is, represents seventy gallons of Martini cocktails. Here is the formula: Absinthin, 1 gram; alcohol, 5.60 gallons; distilled water, 64.40 gallons; yellow aniline for coloring. It would take many pounds of sugar to sweeten this concoction, but we use instead a teaspoonful of saccharine.

"We can make an egg from custard powder which might deceive the eye and the palate, but the body would not fatten or receive nourishment therefrom. There are no proteids, no fats in it; and yet, colored with yellow aniline, we have a very presentable omelet. We achieve a very excellent banana from a mixture of amyl acetate and butyric ether; quince we find in ethol pelargonate; lemon in citric acid; apple is an alcoholic solution of amyl valeriante. Jams and jellies are easily made from glucose, which elements we reproduce in the laboratory by mingling starch with sulphuric acid.

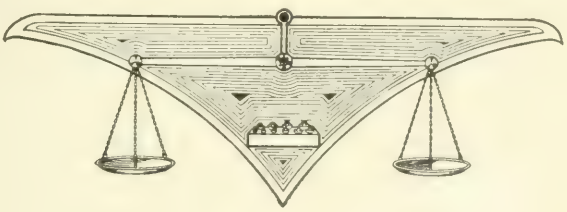
"I forgot to tell you," the latter went on, "that I did make the butter—butterine—compounding it of 'oleo' oil, a certain refined lard, artificial milk, and carrotine, a yellow coloring matter obtained from the carrot." Here Doctor Stillman exhibited a jar of his butter. He said it would turn white in the light; but that otherwise it would not suffer at

all in comparison with genuine butter.

Questioned concerning his assertion as to the average innocuous qualities of food adulteration, Doctor Stillman replied with a story.

"I sent my boy to the store to buy a pound of the cheapest raspberry jelly," he said. "The boy brought back something which looked and tasted like raspberry jelly, but which never saw a berry. It cost twelve cents. The cheapest possible cost for raspberry jelly—it has been computed—would be thirty cents a pound —the real raspberry jelly, I mean. That represents the bed-rock cost, aside from the labor cost and the profits. Now I analyzed that raspberry jelly, and found it was made of apple pulp after the cider was squeezed out, glucose, and a few other materials. It is true that it would not appeal to the educated palate, but it brings the luxury of raspberry jelly within the reach of the very poor. It was entirely harmless; it was nourishing. The only harm was the fact that it was labeled raspberry jam, when it should have been labeled as an imitation. I could give you many other instances of a similar kind; but to no different purpose."

At the present time Dr. Stillman is limiting his dietarian researches to a small scope. He has a government commission to test paints and oils and like substances submitted for use in Panama, and there is little time for aught else, in consideration of this laborious work and of his professional duties to his classes of students at the Institute.



How Did She Mean It?

A CERTAIN Leavenworth man came down to his office the other day, grinning all over his face. All morning long he hummed and whistled, till his partner asked him what he'd had.

"My wife told me this morning that I am a model husband,' he answered proudly.

"I don't call that much of a compliment," said the other.

"I'd like to know why not?"

"Well you just look that word 'model' up in the dictionary," was the advice.

To the dictionary he went, and this is what he read: "Model—a small pattern; a miniature of something on a larger scale."

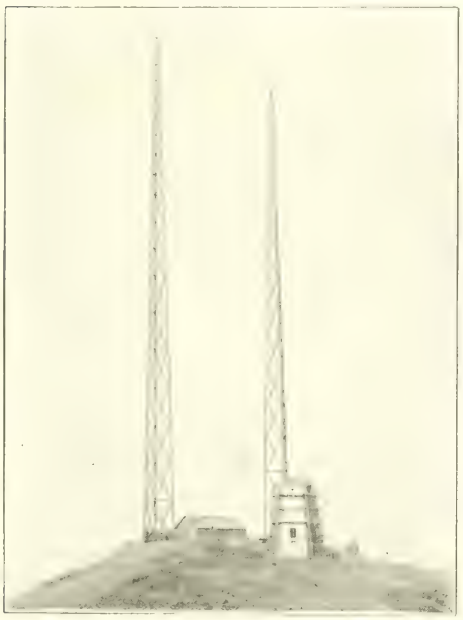
—*Kansas City Journal*

Soundless Whispers to Ends of Earth

By J. Mayne Baltimore

All the far-flung islands of the Pacific will shortly be bound together with the invisible chains of wireless telegraphy. From tall towers, already standing on the top of a California mountain, an electric current of unprecedented voltage will flash signals which may be heard not only in Hawaii and far-off Samoa, but even on the eastern shores of Japan and the Philippines; while, at the same time, ships, moving like atoms across the face of the waters, may keep in constant touch with land.

Rising 300 feet into the air, the two great towers have just been placed in position on the very crest of Mount Tamalpais, in Marin county, California, about twelve miles on an air line north of San Francisco. These two gigantic towers were constructed and hoisted into position by the Pacific Wireless Telegraph Company, and are to be used in connection with its great Oriental and Pacific Coast System.

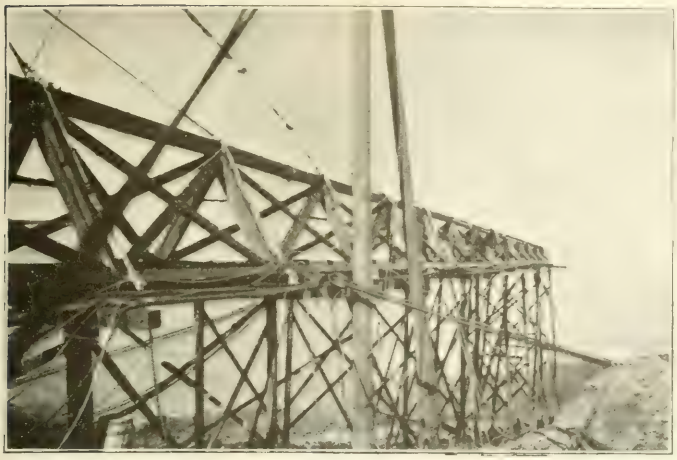


Towers of the Great Wireless Station on Mount Tamalpais, California.

The bases of the towers are 2,600 feet above sea-level, and are only a few miles from the ocean. From the long line of glittering breakers, the apexes of the towers rise 2,900 feet; and they can be distinctly seen for a radius of fifteen miles in clear weather. Perhaps there are no taller wireless towers in the world, and certainly none occupying so lofty a position above sea-level. To construct these giants, convey them to the pinnacle of Mount Tamalpais, and finally hoist them into vertical position, proved a most difficult and daring feat of modern engineering. For it must be borne in mind that each tower was hoisted intact—all complete. Each is 300 feet long, and the base 20 feet wide, the entire structure, as finished, weighing 60 tons. At the apex, each tower is four feet wide.

At first glance the towers appear as if constructed of iron, as they are painted black; but, as a matter of fact, they are mainly built of strong Oregon fir, very securely bolted and braced with steel. It was necessary to construct these towers as strongly as possible, and yet with reference to lightness. Owing to its altitude, exposure, and proximity to the sea, the summit of Mount Tamalpais is the target for constant and tremendous gales and fierce tempests.

If these towers had been constructed oblong in elevation and square in plan—that is, of the same size from base to apex, they could have grown from the foundation upward, timber upon timber, and there would have been no difficult engineering problem to solve in raising them. But a square tower would offer too much resistance to winds and storms.



WIRELESS TELEGRAPH TOWER ON MOUNT TAMALPAIS, BEFORE BEING LIFTED.

An equilateral triangle was therefore the plan determined upon. They were built in convenient sections at Oakland, the work requiring several months. The problem of conveying the heavy sections by steamer across San Francisco Bay, and then to the lofty summit of Tamalpais, proved a slow and herculean task. From mountain base to crest the ponderous parts were carried over a little railroad that wound along like a wounded serpent up the steep declivities—about 8½ miles long.

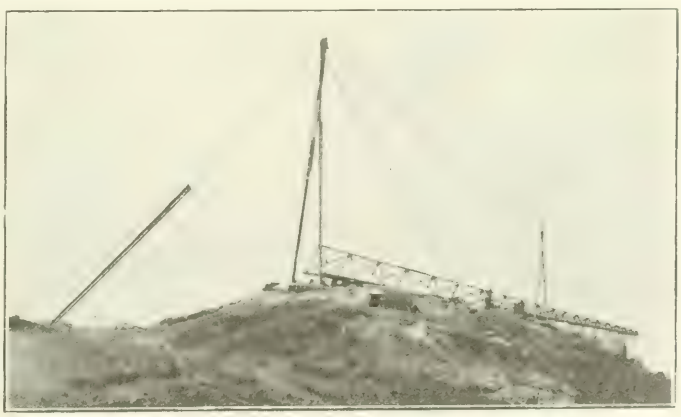
At length all the sections were safely landed on the summit. There were also carried up massive chains, steel cables, tackle, ropes, capstans, heavy timbers for "shears," derrick, donkey engine, etc. Then the slow labor of fitting the sections together, and bolting and bracing them, began. After this work, came the greater difficulty of hoisting each tower into position.

By means of two powerful crab-capstans, each massively anchored by chains to the solid rock, the monster crossed masts, or "shears," were raised, by means of which the towers were to be hoisted. These masts were each 140 feet long, and the pair weighed 18 tons; so that the problem of putting them in position, and holding them securely by guy cables, was of itself no simple one, and the successful solution argued a favorable outcome for the more difficult one of raising the great towers. However, the latter task was accomplished very successfully, though slowly.

From these shears extended a heavy cable to the prostrate tower, around which were eight lashings. The first lashing was made 150 feet from the base, or "heel," and the last lashing 50 feet from the top. By "bridles," these lashings were joined in various groups. The last bridle represented the main purchase of the cable in hoisting each tower.

It was not possible for men working on the steep side of the mountain to "pay out" the guy cables uniformly, as the towers rose; so cavils were arranged on the front legs of the towers, at the heels, and every guy wire came to a cavil and was numbered. The men were similarly numbered, and their movements easily controlled by the foreman in personal charge of operations.

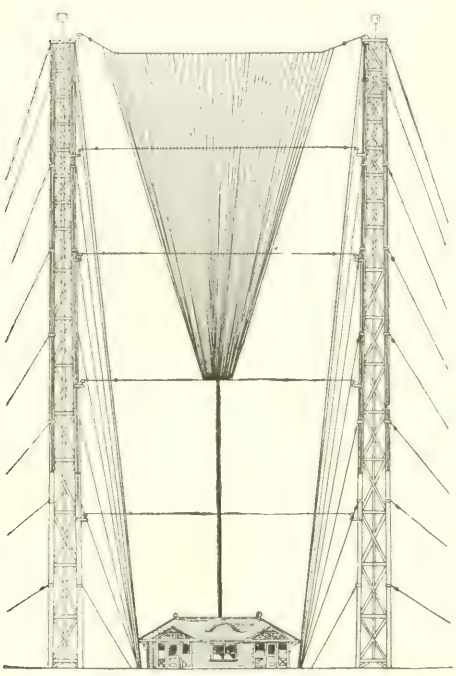
Thus, with the combined power of donkey engine and capstans, and a large force of men assisting, these huge towers were successfully hoisted into vertical



ARRANGING GUYS FOR LIFTING TOWER INTO POSITION ON MOUNT TAMALPAIS.

position—though rising slowly. When once perpendicular, the base of each was very securely anchored, and the upper parts braced by powerful steel guys, the lower ends of which were fastened to solid rock. In addition, six strong steel cables were stretched, at regular intervals between the base and top of the towers, to support the intricate network of wires, and to hold more securely the towers against the fierce gales.

The hoisting of these huge towers—



ANTENNÆ STRUNG FROM TOWERS OF WIRELESS STATION ON MOUNT TAMALPAIS.

and that, too, in the teeth of heavy winds—must be recorded as a remarkable engineering feat. It was carefully planned and accomplished without the slightest accident. In order to clear a foundation space for the base of these towers, 150x40 feet, it was necessary to blast 600 tons of rock from the sharp apex of the mountain. Much other heavy blasting was needed to clear the way for the 1,080 feet of temporary, special railway track.

The towers are placed 115 feet apart, and are so firmly guyed and braced as to resist any wind force short of a hurricane.

The induction coil now under construction at Los Angeles, to be used in wireless transmission, will measure 15 feet in length, and will weigh approximately four tons. It will throw a spark fifteen feet long and as large as a man's body. Two thousand miles of No. 30 silk-insulated wire will be required in the building of this immense coil, and in controlling its enormous potential of 5,000,000 volts, at least 3,000 pounds of copper wire will be suspended between the two great towers. This wire is shown in the accompanying illustration, connected with the central station by means of a single great insulated wire.

A serious problem will be one of proper insulation. More than a ton of specially prepared paper and beeswax will be used in the huge coil itself, and it will be inclosed in a double glass case, with rubber padding between the plates to prevent their being damaged by the heaviest electrical discharge. The aërial wires are to be protected by glass and rubber, and on the 48 guy wires, blocks of Australian iron bark, tested and boiled in paraffine, will aid in preventing any appreciable loss of current through the atmosphere.

In order to appreciate the magnitude of the equipment, it is only necessary to compare it with that of other stations that have been successfully operated. For example, in one of his early attempts to communicate from England to France, across the English Channel, Marconi used a 10-inch induction coil, by means of which he caused a spark to pass through a spark gap about three-fourths of an inch in length. The pole supporting the air wires was only 150 feet high.

The total cost to the company of building the huge towers alone, will approximate $50,000. Connection will very soon be established with many points along the Pacific Coast, from Bering Strait to Central America, and to the remote Orient.

The 2,100 miles of water that separate San Francisco from Honolulu, will be annihilated by direct, constant communication. All passengers on steamships making voyages may be in daily touch with the happenings in the United States and the world. Assurances have already been given that all the prominent trans-Pacific and coastwise steamship lines will equip their vessels with wireless apparatus. The main distributing headquarters will be located in San Francisco.

Glass Bridge Half a Mile High

By Elihu Palmer

THE State of Colorado will possess, within a few months, the highest bridge in the world, over the deepest chasm in the Rocky Mountains—one of the deepest found anywhere. This extraordinary structure is the outcome of the ever-alert western spirit of enterprise, and especially is it one of the logical goals for which rival aspirants for supremacy in the tourist business in the Centennial State are ever straining.

Probably by the midsummer of 1906, travelers between the Mississippi Valley and the Pacific Coast may enjoy the opportunity of passing over this high bridge, which is indeed regarded as the pinnacle of sensational features of entertainment that are continuously being introduced for the greater attraction of pleasure-seekers to the peaks and valleys of the Continental Divide.

The proposed highest bridge in the world is being constructed over the far-famed Royal Gorge of the Arkansas river; and the Royal Gorge is the narrowest point in the also phenomenally famous scenic Grand Cañon of the same stream—the great gate, as it were, through which the Arkansas river empties its enormous accretions of water, very soon after the same have been gathered from the melting snows, 150 miles above, in the vicinity of Leadville, onto the plain once known as "The Great American Desert."

At the point in the Royal Gorge where

TYPICAL TOURIST PARTY ON HANGING BRIDGE IN ROYAL GORGE.

the bridge is to be stretched, the abysmal rent in the earth's crust is but 50 feet wide at the bottom and 230 feet wide at the top. The walls rise almost perpendicularly, and are granite, decomposed and iron-stained until the colorings blend into innumerable pleasing effects upon the senses. The rent discloses the oldest geological formations known to writers of textbooks on that subject. The herculean strength of the stupendous forces which have here displayed their handiwork in such exceptionally peculiar manner, suggests many subjects for theory and speculation. The Gorge, therefore, has always been a most attractive point of rendezvous for all classes of travelers "over the range."

That veteran explorer, Gen. John C. Fremont, when on his first trip toward the Pacific Coast by this route, found the Indians regarding the Royal Gorge with much reverence. They considered it the dwelling place of the Deity, and scarcely ventured closer than five miles from its dark, dismal recesses, except under extraordinary circumstances in the pursuit of game; and it was during General Fremont's parleying with old, wily Ouray over the employment of some of his young braves as guides through the Grand Cañon, that the famous explorer learned of the crude Free Masonry which the sagacious chief was said to possess, and which, to a large extent, aided the military leader in successfully accomplishing his mission.

But notwithstanding the utilization by General Fremont of his Free Masonry, so far as was possible, upon the Indians (through their exalted and influential head), none of the warriors was willing to accept the honor of piloting the military cavalcade of the white man into the presence of the Great Spirit, thought by them to dwell among the cavernous rocks and pinnacles of the long cañon. It reverberates as continuously now as then with the roarings of the river as it rushes madly through its sinuous course. The Royal Gorge is the narrowest of all the Rocky Mountain gulches so far opened to traffic, and also among the most somber and specter-like, for this and other reasons.

Its spanning is one of the most daring attempts made since the abilities of engineers have been taxed by capitalists, during the last ten years, to increase and enlarge advantages for seeing the wonderful alpine-like features that are afforded by the West in such profusion as fully to verify the statement of the late Washington Irving that "never need an American look beyond his own country for the sublime and beautiful in natural scenery."

Little wonder that what the Indians held in such terrible awe has proven of superior interest to the pale-face. Its scenic phases are transcendent, even as disclosed by the heretofore available resources for witnessing its indescribable solemnity, which no pigments on the artist's palette can paint; and now that the prospective additions to facilities for witnessing the grandeurs of this world's wonder are to include the highest bridge in the world, an added attraction is expected to receive public acknowledgment.

The Royal Gorge was not wide enough to admit a railroad track alongside the river, and engineers who built the Denver & Rio Grande railroad thirty years ago were compelled to devise what is known as "the hanging bridge," which has always been considered a monument to the skill of that profession—mostly, however, from the fact of its being the embodiment of an original idea rather than a triumph over obstacles to the end sought.

Huge steel trusses, anchored in the rocks on each side of the river, carry the central weight of the bridge, the subsidiary supports being large steel rods depending from the trusses to the ordinary bridge construction, which is seventy feet long, extending parallel to the course of the stream. Upon this structure, Rio Grande trains have been stopped by the management for many years, to afford passengers opportunities for witnessing the interesting sights of the vicinity.

From the railroad tracks, the eye, looking upward, can scarcely comprehend the stupendous height of the cliffs whose summits pierce the heavens half a mile above; and while in the past the view from the hanging bridge has been voted one of the most sublime and imposing in the Rockies, the advantages for gaining

GLASS SUSPENSION BRIDGE OVER ROYAL GORGE, GRAND CANYON OF THE ARKANSAS, COLORADO.

good views of its most picturesque aspects were sadly insufficient.

The cañon is seven miles long, hemmed in by continuous exalted walls of variegated hues; and from the viewpoint occupied by the bridge the kaleidoscopic panorama will include the circuitous cañon itself, with its cathedral-like spires rising here and there amidst the ever-changing colors and shadows, and, in the distance, the peaks of the mighty range to the west, south, and north. Eastward the vast undulating plain stretches to the horizon. A perfect eyesight can distinguish details of the landscape at distances of 25 to 50 miles in the rarefied

Colorado atmosphere from this great height, while tourists carrying field glasses can easily locate independent objects 150 miles away.

The bridge will be 2,550 feet above the railroad track, 22 feet wide, and 230 feet long, and constructed of flat steel and steel cable such as is utilized in suspension-bridge construction. The supporting, curved girders will find substantial

ELECTRIC TRAIN APPROACHING HANGING BRIDGE IN ROYAL GORGE.

lodgment, at each end, in the granite sides of the cañon, where enough space will be chipped out to afford anchorages which nothing but an earthquake can dislodge.

The floor of the bridge will be of plate glass one and one-half inches thick, set in steel framework, through which objects below can be easily discerned, it is expected, by most visitors, without experiencing dizziness. Railings at the sides will be so high that, while those who desire may gaze below by craning their necks through interstices, no danger of falling into the chasm will be present, either to children or to adults. The cost of the structure is estimated at $100,000, which however, does not include the total expenditure involved in the perfection of the promoters' plans.

Tourists will be embarked from the Denver & Rio Grande railroad trains at Cañon City, a pretty town nestled in the midst of highly developed fields and orchards in the Arkansas Valley, six miles east of the hanging bridge.

From this city an electric railroad is being constructed on the north side of the cañon. The route is past the Colorado State Penitentiary, through irrigated orchards and alfalfa fields, thence up and around innumerable terraced hillsides, on and on to the heads of short gulches, over shallow chasms that must be bridged to perfect the switchback system involved, and finally to the summit of the Front range. Although a bee-line distance of but six miles will then have been attained, it will have required the riding over twelve miles of track, laid on an average maximum 4 per cent grade. The cars, which are of the usual interurban pattern, will reach the bridge in twenty-five minutes. The ascent by rail will have been 2,800 feet, while the altitude at the summit is 7,900 feet.

A hotel of modern design and large capacity is being constructed there, as well as other accessories of a summer resort of high class, including trails into the cañon *via* its steep sides, over which mountain climbers may journey afoot or on the back of the patient little burro.

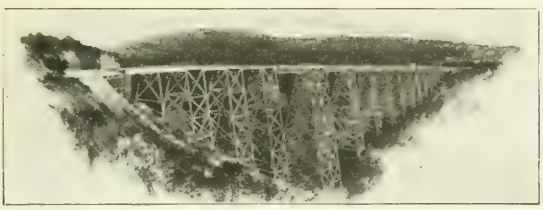
Cars upon which the traveler will have

journeyed from Cañon City will be sent over the bridge, minus passengers, on grade, and all visitors therefore will walk across the chasm.

Once on the south side, the cars will roll back to Cañon City over another 4 per cent grade track, fifteen miles long, built in the sides of mountains and hills, and affording many new and novel views which are impossible from the ascending car. This part of the system will not be equipped with trolley wires, but will depend entirely on gravity for its momentum, and upon improved air-brakes for government.

Upward of $1,000,000 is expected to be spent in developing this new enterprise by the controlling corporation—the Cañon City, Florence & Royal Gorge Interurban Railway Company.

The idea of bridging the chasm had occurred to but a very few people before F. S. Granger, who is a promoter of original ideas and considerable constructive ability, undertook the task, to inaugurate which has required several years of experimenting with surveys. It is only within the past fifteen years that it has been deemed possible to overcome the engineering difficulties thought to lie in the path of building a railroad on either side of the Gorge. Previous to fifteen years ago, engineers would have declared any man a lunatic who suggested such a route as a possibility, even with unlimited capital; but in accordance with the modern advancement in civil engineering, broad-gauge railroad tracks are now constructed over mountain passes formerly considered wide enough only for burro trails, and bridges are built over chasms where geography illustrators twenty-five years ago declared "one false step would be fatal."



¶ Being forced to work and do your best will breed you a hundred virtues which the idle never know.—*Charles Kingsley.*

¶ Never use what is not your own; never buy what you cannot pay for; never sell what you haven't got.—*Commodore Vanderbilt.*

JAPANESE VILLAGE WRECKED BY EARTHQUAKE.
Over one thousand earthquakes traverse the Island Empire annually.

To Foretell Earthquakes*

By John Elfreth Watkins

AN earthquake survey of the United States and its possessions is one of the most recent enterprises of science.

Seismologists—the students of these phenomena—are learning that Mother Earth is a much more tremulous creature than we have previously had reason to suppose. In fact it would almost appear that she is growing palsied as the chill of old age creeps over her.

If it is not straining imagination too much, it may be said that these seismologists are setting earthquake traps in various nooks and corners of our vast domain. These are among the most sensitive products of the instrument maker's fine art. They have a much more acute sense of touch than has been given to man. In fact, they would almost seem to have been endowed with brains, for they automatically write with pen and ink all that they observe, and their records are kept with a superhuman exactitude.

Seismographs Installed

The Government recently purchased in Germany six sets of the most improved apparatus of this category. These, known as "seismographs" or "seismoscopes," have been installed at Washington, D. C.; Cheltenham, Md.; Baldwin, Kan.; Vieques Island, Porto Rico; Honolulu, Hawaii; and Sitka, Alaska.

The Washington instruments are installed in a subterranean vault beneath the Weather Bureau, where they are in charge of C. F. Marvin, Professor of Meteorology in that institution. The other five sets have just been put in place in the new federal magnetic observatories at the other points named. They are being operated under the general direction of Dr. L. A. Bauer, Chief of the

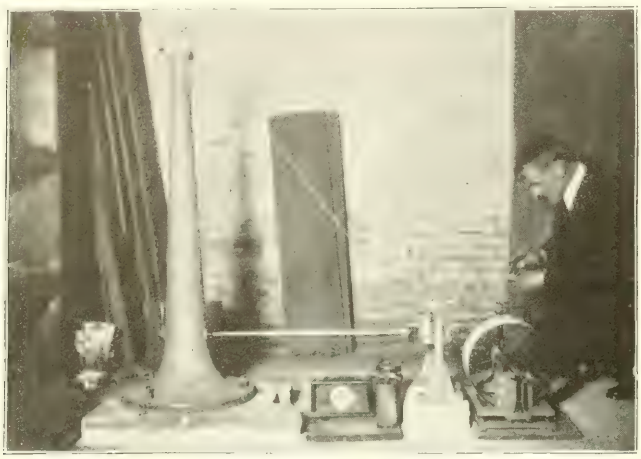
*Reprinted, by request, from TECHNICAL WORLD MAGAZINE for March, 1905. In view of the appalling catastrophe at San Francisco, this article is full of absorbing interest. The illustrations are from actual photographs, and give a vivid idea of the effects of even a comparatively mild earthquake.—The Editors.

Division of Terrestrial Magnetism, United States Coast and Geodetic Survey. Added to this chain of stations, are others at Manila, Philadelphia, and Baltimore. The first-named is in charge of Father Algue, a Jesuit scientist of the Manila Observatory. The Quaker City's station is at Swarthmore College; and that of Baltimore, at Johns Hopkins University, where it is under the direction of Prof. H. F. Reid, the most eminent of American seismologists. Professor Reid's station is serving as the clearing house, so to speak, for all of the American earthquake data; and, as soon as the co-operating stations shall have completed a sufficient continuous period of observation, he will issue statistics which no doubt will surprise us all.

THE GREAT EARTHQUAKE AT CHARLESTON, SOUTH CAROLINA, AUGUST 31, 1886.
Street scene just after the severest shock.

Foreign stations, also, are co-operating in this work, particularly those at Toronto, Ont., and Victoria, B. C., under the meteorological establishment of Canada; and others at Mexico City; Cordoba, Argentina; and Arequipa, Peru. In fact, arrangements are being effected,

looking to the perfection of an earthquake survey of the world under the auspices of the International Seismological Association. This society has been organized for this special purpose under the leadership of Professor Gerland, Director of the Seismological Observatory at Strassburg, Germany. Japan will fall into line with nearly 1,000 stations; Italy, with 15; England, with 3; Scotland, 2; India, 4; Canada, 2; Australia, 3; Russia, 3; and Spain, 2; also South Africa, Egypt, Ceylon, Java, Mauritius, New Zealand, Syria, Trinidad, Mexico, Peru, Argentina, and Germany, each 1. Thus Old Earth will have left but few surface areas where she may twitch undetected.



NEW TYPE OF SEISMOGRAPH ADOPTED FOR GOVERNMENT STATIONS.

But, as to our own earthquake survey:—The six seismoscopes which we have installed are regarded as the most perfect of their class. The pattern is a modification of the recent invention of Professor Omori, secretary of the earthquake investigation committee of Japan. Japan is the great earthquake country, and has gone so far as to institute a chair in seismology at the University of Tokio.

How the Records are Made

This new type of seismograph consists of a heavy weight, so suspended in front of a tall iron pedestal as to be always in neutral equilibrium and unaffected by any influence other than gravity. While the earth is quaking and trembling directly below it, it is standing still for the moment. It is spanned by an iron arch, whose base is a stone pier, penetrating the earth. All earth movements are directly communicated to the arch. Hence, when even the slightest tremor takes place, the arch moves therewith, but the weight below remains quiescent, as already said.

Attached to the stationary weight by a jeweled pivot, is a long, slender arm of aluminum, with a writing pen at its outer end. Upon the same foundation with the arch, and sharing all earth movements therewith, is a revolving wheel whose broad tire is a sheet of paper, against which the writing pen rests. The principle of the instrument, in a nutshell, is that each earthquake moves the paper against the pen, and records its tremors in zig-zags or curves. But, by a delicate adjustment, the aluminum arm exaggerates the earthquake tremor to a measurable degree.

The wheel, with its paper tire, makes one revolution every hour. The recording pen commences its record on one edge, and, by aid of a thread on the wheel's axle, is made to trace gradually a perfect spiral over the endless band of paper, unless an earthquake interrupts. Thus the normal lines of the pen do not overlap. By means of an electromagnet attached to a specially made clock, a current is communicated every minute to another pen point, following the first and resting upon the same paper. The latter gives a hitch each time it receives an electric impulse, and thus checks off minutes along the spiral line traced by the first pen, which is "keeping tab" on Mother Earth's antics. A new paper is placed on the wheel at the same minute each day. It being known precisely when a new record is set, the exact time of a zig-zag earthquake line can be determined by counting the minute marks on the paper; and the exact

second of an earth tremor's beginning can be learned by applying a delicate scale dividing by sixty the space between two minute marks.

A pair of these instruments is necessary at each station. One, always pointed north and south, records earthquake vibrations moving east and west; the other, directed east and west, detects north and south movements. Each tremor makes its record on both instruments simultaneously. The zig-zag lines will be seen to differ materially when the paper strips are taken from the wheels and carefully compared with a scale. The exact direction of the earthquake wave, as well as its horizontal width, is thus measured to a nicety.

Delicacy of the Work

Only one out of several hundred or perhaps several thousand earthquakes recorded by these instruments, is perceptible to the public or reported by the newspapers. Typical of these earthquakes noticed month after month, was one caught by the Weather Bureau's seismograph just after its installation. On looking over the record sheets at the time of the daily change, Professor Marvin discovered a zig-zag perfectly inscribed and showing all the recognized characteristics of earthquake phenomena. The curve showed that there were preliminary tremors commencing at 9:29 A. M. and lasting five minutes. The main tremors then succeeded for 2 minutes 36 seconds. Terminal tremors lasted for 26 minutes 24 seconds. The total disturbance lasted 34 minutes. At the height of its activity, the earth beneath the instrument moved only a trifle more than a hundredth of an inch, from side to side. Small wonder, then, that the public was unaware of the shock.

But this tiny earthquake, undiscovered by press or public, traveled across the continent and was felt on the Pacific slope by a similar seismograph. Without announcing the fact that his instruments had recorded the shock, Professor Marvin filed their records away and corresponded with other stations. He found that those of Baltimore, Victoria, and Toronto had recorded the shock at about the same time. By careful computation, he discovered that its first strong waves traveled from Victoria across the continent to Toronto in a fraction over eighteen minutes, and from Toronto to Washington in one and one-half minutes. The stronger waves traveled at the rate of nearly two miles per second.

That earthquakes will some day be systematically forecast, is a prophecy which may sound visionary, but one which has some scientific foundation. The Japanese seismologists now believe that they find indications of earthquakes' approaches upon the records of their magnetic instruments, preceding directly the effects shown by their seismographs. In other words, they have found what appear to be magnetic warnings of earthquakes. If their theory can be demonstrated, our Weather Bureau will doubtless profit by it; and we may expect, perchance, to see earthquake warnings displayed from mastheads above our public buildings, or to read at the top of the morning paper that Mother Earth will indulge in a shake-up at such or such an hour of the day. Pastors may then have time to gather in their flocks for public prayer, or urban residents may betake themselves to the open country, before the crash comes.

"Craterlet" Caused by Charleston Earthquake.

Frequency of Earthquakes

In 1904, at Baltimore, fifteen earthquakes were recorded by Professor Reid between April 1 and October 21. In Porto Rico, seventeen were observed by the national instruments between April 1 and July 1; in Honolulu, thirteen were counted within this latter period. According to these figures—upon the basis of which it is hardly fair to generalize, however—an earthquake shakes our Eastern States on an average once every two weeks, while the frequency is considerably greater both in Hawaii and in Porto Rico. The national instruments have not been installed a sufficient time for any statistics to have been gathered elsewhere.

Earthquakes and magnetic storms are found to be related, and it is partly for this reason that the Government's new magnetic observatories are being equipped with seismographs.

FISSURE CAUSED BY CHARLESTON EARTHQUAKE.

The primary object of the national earthquake survey will be the determination of the velocity with which shocks

and vibrations are propagated over the surface of the earth and through its interior; to locate positions of earthquake origins under the oceans; and, generally, to increase our knowledge of the physical nature of the earth's crust and its interior.

The average velocity of earthquakes, as thus far estimated, is about 1¼ miles per second for the first tremors, and about 1 mile per second for the main shock. After a few hundred miles, the velocity of the first tremors increases, and

ONE OF THE VARIED PHASES OF EARTHQUAKE EFFECTS.
Here an area was depressed 25 feet below its former level, leaving a terrace 25 feet high.—View taken in Japan.

over long distances has been estimated to be greater than that of the waves of compression through steel or glass. The fact that the vibrations of the first tremors appear to travel faster than those of the main shock, indicates that the former pass directly through the earth, while the latter follow the longer course around its crust.

Mother Earth appears to quake, at some point or other, on an average, once every half hour. In Japan, more than a thousand earthquakes per year are regularly recorded. Great Britain's dominions are crossed by tremors about 100 times a year. For our own country, we have no complete figures as yet.

In both hemispheres, according to such statistics as are now available, earthquakes are more frequent in winter than in summer. This is believed to be due to the fact that in the cold season the greater weight of snow and the greater pressure of the atmosphere imposes a heavier strain upon the earth's crust.

How Earthquakes Operate

In many instances, shocks so faint that they cannot be perceived by our senses when we are upon or near the ground, are distinctly felt upon the top floors of tall buildings. Severe shocks are accompanied usually with sounds comparable to those of near or distant explosions. Other effects of great earthquakes are fissures and faults in the earth's surface; the raising or lowering of areas of ground; the drying of springs; landslides, land waves, and tidal waves. The fissures in the earth's surface may open widely, and immediately close, or they may remain open with a width of several feet. Some have had such immeasurable depth that water from streams has flowed into them for days without filling them, while others have belched up gases, water, or mud, appearing as if from the crater of some slight volcano. Sometimes large areas of land are depressed, forming the basins of new lakes; and in frequent instances a large area of land

HOW AN EARTHQUAKE MAY AFFECT STRAIGHT RAILWAY TRACK.
View taken in Japan.

has fallen to a lower level, leaving a definite wall or terrace between it and the soil not so affected. These severe shocks sometimes precipitate boulders down mountain slopes, or cause landslides or avalanches that bury settlements of people or throw dams across streams, creating lakes where none before existed.

Subterranean earthquakes are observed to give rise to surface waves similar in formation to those caused by dropping a pebble into a brook, but much more enormous in height, and often attaining the fatal form of a tidal wave washing inland and drowning hundreds of people. Luminous appearances have been reported as accompanying earthquakes occurring at night; and it is thought by some that these phenomena are due to the friction of moving masses of rock. According to this theory, temporary electric currents are, as a result of such friction, established in the line of the earthquake. At or near the starting point of great earthquakes, there is sometimes evidence of the bodily displacement of many cubic miles of material. When this matter is of volcanic origin, it is, according to one authority, almost invariably magnetic, and its readjustment produces magnetic storms.

Historic American Earthquakes

Our most notable earthquakes have been those occurring in New England, in 1638; New England and New York, 1663; New England, 1727; New England and the North Atlantic States, 1755; the Mississippi delta, 1811-12; Inyo Valley, California, 1872; and Charleston, S. C., 1886.

The earliest of these—on June 1, 1638—occurred between 3 and 4 P. M. The weather was clear and warm, and the wind westerly. All of New England, it is recorded, was violently shaken by a convulsion accompanied with a noise as of continued thunder. The main shock lasted about four minutes, during which the earth shook with such violence that in some places people could stand only with difficulty, while many movable articles in houses were thrown down. The earth is reported to have been unquiet for twenty days following this shock.

The earthquake of 1663 occurred on January 26, and was felt in Canada, throughout New England, and in New York. In Canada, says a contemporaneous writer, "Doors opened and shut of themselves with a fearful clattering. Bells rang without being touched. Walls were split asunder. Floors separated and fell down. The fields put on the appearance of precipices, and the mountains seemed to be moving out of their places." It is recorded that during this convulsion of nature, small rivers were dried up; some mountains appeared to be much

broken and moved; while half way between Quebec and Tadousac, at the mouth of the Saguenay, two mountains were shaken down, forming a point of land which extended some distance into the St. Lawrence River.

The upheaval of 1727 was felt at 10:40 A. M., October 29. The main shock lasted about two minutes; and its course seemed to be from the Delaware River to the Kennebec, a distance of about 700 miles. Pewter and china were cast from their shelves. Stone walls and chimney tops were shaken down. In some places doors were burst open and people could hardly keep their feet. On the same day, the West Indian island of Martinique—where in 1902 occurred the terrible eruption of Mont Pelée—was threatened with total destruction by an earthquake lasting eleven hours. And in this connection it is an interesting fact, that during the recent disastrous outburst of Mont Pelée, no earthquake shocks were recorded by the crude seismograph then mounted in the Weather Bureau at Washington, although severe magnetic storms were observed with the instruments of the Coast and Geodetic Survey.

The earthquake of 1755 was felt from Chesapeake Bay to the coast of Nova Scotia—or for about 800 miles. The shock occurred on November 18, and in the interior of the country it seemed to have extended over a thousand miles from northwest to southeast. In Boston, Mass., a hundred chimneys were toppled over and leveled with the roofs of the houses, while 1,500 others were more or less shattered. The ends of several brick buildings were thrown down, and the vane on the public market was hurled to the earth. At New Haven, Conn., it was reported, "the ground moved like waves of the sea; the houses shook and cracked; and many chimneys were thrown down." This shock occurred at 4:00 A. M., and lasted four and a-half minutes. At the same time there was a great tidal wave in the West Indies.

The Mississippi delta earthquake of 1811-12, known also as the "New Madrid earthquake," was characterized by severe shocks occurring at short intervals during a period of several months. Indeed the entire series of shocks covered a period of about two years. There were few settlers in the country at that early day, and little is known as to the distance at which the shocks were perceptible. The land was plainly seen to rock with a wave-like motion, which was communicated to the forest trees, some of which were uprooted while others were permanently entangled with one another. From the fissures opened into the earth, mud

EFFECT OF AN EARTHQUAKE UPON A JAPANESE RAILWAY BRIDGE.

spurted up into the branches of trees, and the deep openings into the ground yawned and closed with each successive shock. Lakes which had sparkled in the sunlight of centuries went out of existence, their waters being drained into these fissures. New lakes were created by the falling of the land, which was thus shaped into basins receiving the flow of brooks and creeks. One great area 60 to 80 miles long and half as broad, sank from its former altitude.

The Inyo Valley earthquake of 1872 continued for two or three months. The chief shock lasted but a few minutes, and those which followed at intervals were far inferior in violence. Along the base of the mountain range, was created a fissure forty miles long, and the land to the east of it fell several feet. In one place the earth dropped twenty-five feet. The ground also twisted in a horizontal direction. The fence on one piece of property was found to be fourteen feet out of alignment. A river was temporarily swallowed, and a number of springs permanently dried up. Every house in Inyo village tumbled down, and one-tenth of the inhabitants lost their lives.

Twenty-seven people were killed outright by the great earthquake at Charleston, South Carolina, August 31, 1886. Other victims died afterward from injuries received during the catastrophe. A large number of houses were thrown down, and nearly all buildings in the city were more or less injured. The damage to property was computed in millions of dollars. The principal shock occupied about one minute, others following with diminishing violence. Destructive tremors occurred for four weeks, and others were felt for several months longer. Numerous fissures yawned in the surrounding country, sending forth water and mud and flooding the channels of streams. Railway tracks were dislocated and buckled.

DEVASTATION WROUGHT BY A JAPANESE EARTHQUAKE.
"Japan is the great earthquake country."

Had adequate seismographs been in place during any of these great earthquakes, science would have added greatly to its meager fund of knowledge concerning the cause of such convulsions. The next great shock will be followed about the earth, and, it is devoutly hoped, will be traced to its subterranean source.

MOUNTAIN OF NITER ON EDGE OF DEATH VALLEY, CALIFORNIA.—CHINA RANCH IN FOREGROUND.

PHOTO BY PIERLE, LOS ANGELES.

Mountains of Saltpeter

By Harry H. Dunn

TWO hundred and fifty miles to the north and east of Los Angeles, California, lies the sink of the Amargosa river, known on the maps as Death Valley, a fearsome place if one is to believe all the stories that are told of it; in reality a most delightful region through which to roam during the season from October to May. Principally this ill-omened sink is noted as the burial ground of dozens—yes, hundreds—of prospectors and unwary travelers who have ventured out upon its treacherous surface in search of gold or of that which is more precious at times than gold—water.

Beyond this, Death Valley is known to the outside world as the receptacle of thousands of tons of crude borax, deposited during the ages that have passed since the Juro-Triassic sea overlaid all this part of the great basin. In it, too, have been found one or two very rich silver mines, and several good copper prospects, which latter, owing to the lack of water, have never been worked. Through all this country, the writer has traveled, sometimes on horseback and muleback, most of the way on foot; and the thing which interested him most in all the miles of sand was neither the borax, nor the mines, nor the dead men's bones, but the thousands of acres of crude niter that lie fallow to the chemist on the south and east of the valley itself.

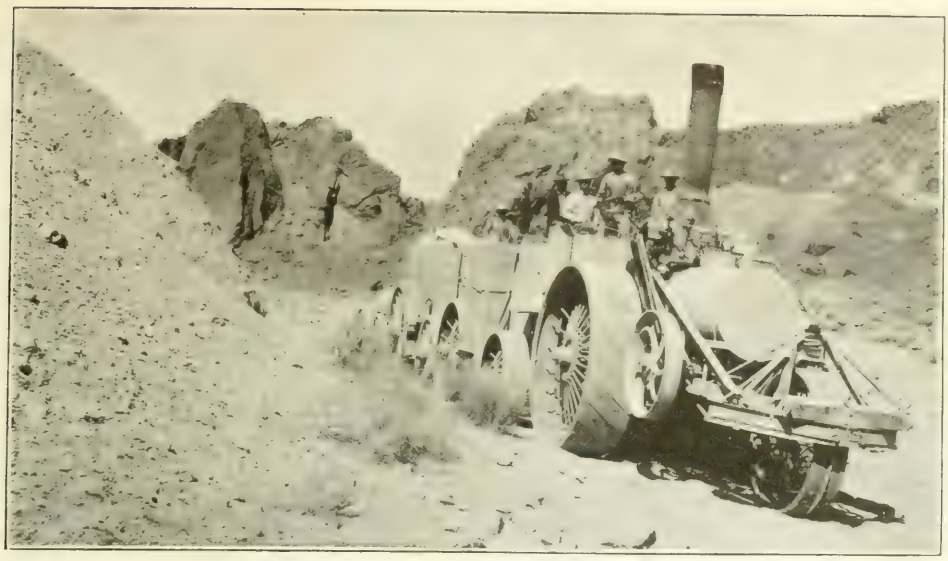
Imagine, if you can, mile on mile of level desert, smooth as a floor, yellow as Indian maize, and bearing on its barren

surface no sign of vegetable growth, not even a bit of scrubby greasewood. Bound this plain with the brown lava hills of the rim of Death Valley on the one side, and on the other with low, rounded knolls of the same yellow stuff as the surface on which you walk, and you have a poor idea of what this deposit of niter is like. So far as I have been able to learn, no part of this great bed has ever been worked. Here and there, shallow prospect-holes, with their crumbling mounds of yellow earth, testify to the fact that the assayer has been here; but that is all. Water is too scarce as yet for its development; when water comes, men who own land here will be made millionaires faster than were Borax Smith and J. W. Searles when borax sold at thirty-five cents a pound.

Under the traveler's feet, the stuff crumbles into a dust fine as flour. After one of the few rains with which this land is blessed, a thin crust forms over the niter field, but it is nothing like the thick soda and borax crusts to be found over the dead lakes in the bottom of the valley. Here, not even a raven can walk about without leaving a plain trail; there the Piutes ride their horses rough-shod over the unyielding surface.

But the niter on the flat is leached out from the hills above, and is so weak that it tastes like powdered clay, far different from the bedrock of the hills. To see these hills in the mind's eye, one must imagine that some giant has emptied myriad huge cups of damp cornmeal over the level desert, and there they have dried out, still retaining their original shape. Each hill is rounded by the winds and the rains and the terrible cloudbursts that sometimes blot out whole townships of mountain ranges, until they all look exactly alike. No worse fate can be imagined, than to be lost in these interminable hills. I know, because I was so lost for the greater part of one day; and only from my absolute knowledge of the few towering peaks of the desert and my ability to locate their hazy tips, was I able to escape. None of these hills is

OLD METHOD OF HAULING MINERALS FROM THE DESERT.
The abrupt cliffs shown in the background are solid niter of about 14 per cent purity.



NEW METHOD OF HAULING ON THE DESERT.
Traction engine hauling a carload of borax through niter hills on the rim of Death Valley.

over 200 feet in height, and the great majority of them are scarcely of one-quarter that altitude.

Over all, the hills are covered with a granular deposit to a depth of from one to two feet. In places this thins down to two or three inches. It is powdery, light yellow in color, and engulfs the climber's feet at every step. Between the fingers it has the feeling of very fine sand, but on the tongue that grittiness disappears and it becomes a flour-like substance, similar to the leached-out deposits of the level places below. To the taste it is acrid, almost acid; in some parts of the hills, where the bedrock is exceptionally strong, it is bitter, and the demands it makes on the tongue of the taster, for water, are most insistent. No streams run through any of these hills. Now and again there are fissure springs scattered through them, but the water is swallowed up by the thirtsy soil ere it can bubble out to form a stream. It is no exaggeration to say that the strongest brook of all this region does not flow twenty feet from its source, before its bed is one with the deadly dryness of the hills roundabout.

When rain falls on these hills, the surface of the thin super-deposit becomes as pockmarked and pitted as was ever the face of a smallpox patient. Then indeed they present a peculiar sight; and then is when, of all the twelve months of the year, water gets in its work on the niter deposit and leaches it out to feed the lower slopes of the knolls and the plain below. Cloudbursts occasionally strike here, mostly during the late spring months, and then whole hills are picked up bodily and spread out over the floor of the desert, leaving a space as level as was ever the bed of Death Valley itself. In such cases, great blocks of the underlying bedrock will be found scattered over the plain, there to lie until the next rainy season disintegrates their mass and makes them one with the yellow granules underfoot.

And it is of this bedrock that chemists who have examined the deposit expect the most in the way of values. Underneath the layer of granules which I have described as covering the cones, is the mound of this bedrock, which is not rock at all, but a substance of about the consistency and hardness of dried-out clay. It is dark, chocolate-brown in color, heavily streaked and marbled with veins of gypsum, a mineral found commonly throughout this part of the desert, and also containing occasional small deposits of mica, though both of these are present in such infinitesimal quantities as to preclude the possibility of successful working.

This bedrock follows the contour of the hills exactly, and in all the cones uncovered by the party with which I was connected, it was more or less cracked, so that a small blast properly set off dislodged large blocks of the bedrock. Some of these were very regular in outline; and

land beneath the niter beds—which latter are merely superficial deposits and do not extend down into the earth at all—must of necessity be so soaked with the leachings from these hills that it, too, can be worked to advantage when the ten or fifteen thousand acres of yellow granules

ONE OF THE LARGER NITER BEDS, WITH LAVA WALL IN FOREGROUND.

there is more than one abandoned Piute hovel on the edge of Death Valley built of nothing but these blocks, its roof a mere screen of mesquite branches. It is also noticeable that the cleavage of all this bedrock is along the lines of the gypsum veins, a rather remarkable coincidence, it seems to me, and one that would indicate the slow ingrowth of the latter mineral into the niter deposits. The mica does not seem to have any particular effect on the breakage.

To the taste, this bedrock is of a fiery bitterness, so strong, indeed, that to hold it to the tongue for more than an instant is to invite a blister. How pure this is, may be judged from the fact that hurried and necessarily incomplete field assays credited it with more than fourteen per cent, the valley deposits giving about one per cent, and the "blanket" which covers the hills some ten per cent. Niter of this degree of purity can, of course, be worked at an immense profit when that desideratum of all desert mineral workings—water can be had. The

and brown bedrock have been converted into a salable product.

Around the China Ranch, the niter deposits are especially large and rich. This point is some fifty or sixty miles from Death Valley proper, on the road to Manvel in Nye county, Nevada. From the south end of the valley, just where the Amargosa makes a sudden bend to the north before entering the sink, clear over to the Nevada line, the niter beds extend; but at either end of this limit they are very thin, apparently only the remains of once greater deposits, even, than now exist further out. At the ranch mentioned, they attain their maximum size. Here they overlie great lava fields of unknown depth, and the hills are of greater height than in other sections of the beds visited by me.

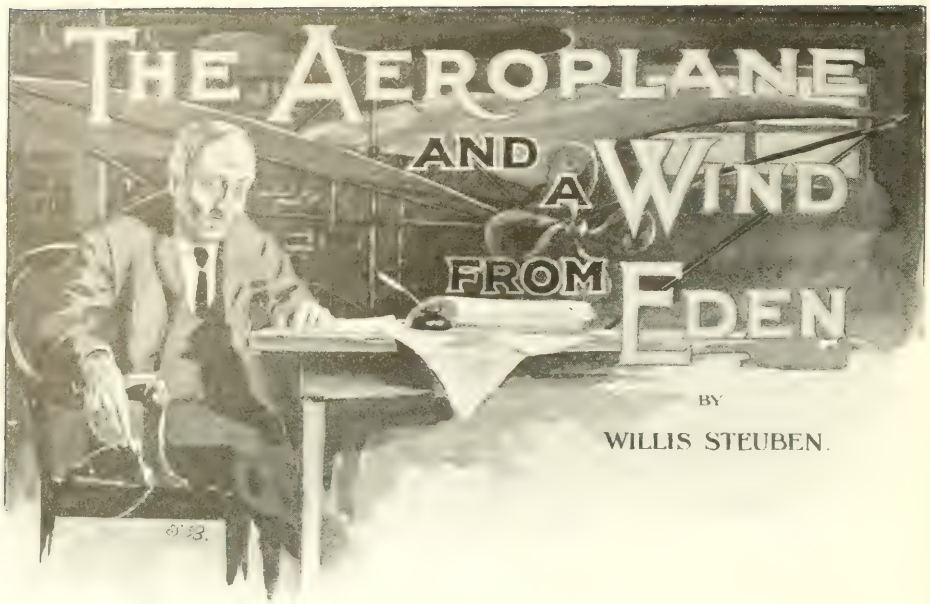
The Willow Creek branch of the Amargosa river flows past the China Ranch, and forms a strip of green between two bands of golden yellow—the niter hills—backed by the reds and sepias of the lava flats and the still standing rims of long-

dead volcanic cones. Much of this country shows evidence of a great lava flow in long-dead years. Many of the springs are warm, and here and there one is found whose waters come uncomfortably close to the boiling point. Around none of these springs, however, has the niter been deposited to any great extent, while along the banks of the two streams named above, the long, yellow fingers of the hills seem to reach out as if to grasp the cooling waters in their parched embrace. During the rainy season, some of these hills "leak" copiously into the brooks, and the result is that the water for miles below is unfit to drink. Fortunately there are few who are called upon to use the water, and only the wild animals of the region suffer. At the ranch itself the house is built close up into the lee of one of the largest of the niter hills; and the ranchman tells me that in the many years he has lived there he has been able to see no diminution in the size of the adjacent deposit, so it is very probable that but little is lost by the leaching of the rains.

At all seasons of the year there is an abundant supply of water in both these streams and here seems to be the most likely basis of operations—when the railroad comes through. And there you are—where transportation can be had within easy distance, there is no water; and where there is water, there is no means of shipping the product out. So there the niter miner is left, as much isolated on the rim of Death Valley as though he were prospecting amid the craters of the moon. Yet, all in all, this is a most interesting country, and one which it will pay any traveler who has the slightest scientific bent to visit and to inspect thoroughly.

Credo

"I SHALL pass this way but once. If, therefore, there be any kindness I can show, or any good I can do to my fellow human beings, let me do it now. Let me not defer or neglect it, for I shall not pass this way again."



I

"AS the matter stands," said the young man, resting both elbows on the table and looking across at the young woman, "my father's son has no chance, because his paternal ancestor is a blithering, impractical, warm-hearted, careless, good-natured old idiot with the best disposition in the world, but with no inclination to do anything which could be of the slightest use to himself, no matter how much use it might be to other people."

They had the restaurant practically to themselves. Even the waiter, having come early into possession of his fee and having removed the dishes, had removed himself. Their corner was deserted.

"You shouldn't speak of your father that way," said the young woman, sharply.

"I am quoting," replied the young man. "I added 'warm-hearted' and 'good-natured' to the quotation, although I understand they are conceded by the signatory powers."

"Signatory powers?" inquired the girl.

"Represented in this case by your father, your mother, and yourself."

"You know very well, Dick," said the girl, "that no one in the world has more admiration for your father than I have."

"Admiration, yes, Lang it! But, Mary, you fear that his son has inherited his—well, call it impractical—disposition, and for that reason you will not trust yourself to him, and your parents would not allow you to if you were willing."

He drew out a case, asked permission with a look, and lighted a cigarette. The girl in her turn leaned forward on the table and spoke earnestly.

"I am not afraid of his father's son," she said. "I believe in him. It is because of this that I want him to do something. My father is violently prejudiced. Now, Dick, is he all wrong if he cares at all what becomes of us? Dick, have you ever given any thought to responsibility? Don't you think you ought to show that you can do something before we risk ourselves? I am not afraid that I shall have to take in washing. I am thinking more of you than I am of myself. I should not like to go against my

father's wishes, but I would do so if I did not think he was right, and if I did not think that you could 'make good' if you had to."

"And all this suspicion," said the young man, leaning back in his chair, "is because my good-natured paternal ancestor prefers to invent airships just now rather than washing machines, or new burglar-catches on windows, or something useful like that."

"No, it is not," said the girl. "My father thinks that way, and so does my mother; but I think your father has a perfect right to invent airships or submarines or wireless telephones or anything he likes. I do not think, though, that his son should think that this gives him the privilege of leading an irresponsible life. If you want such a life, you should not seek responsibilities, and I'll be a responsibility."

"I guess your father's right," he said, wearily. "It's in the blood. Father's work has made him rich three times, and he has lost it. He never cared when he did. He is just as happy now as he was when his factories covered forty acres."

"But, Dick, I know you better than you know yourself. *You* wouldn't be. You want the good things of life. You want the praise of people. You needn't deny it. When people say that you are such a brilliant boy, and could do so much if you tried, you like it."

"I don't try, because if I did I would fail, and then they would see that they were wrong," he said flippantly.

"You have tried—half-heartedly," she answered, "and always something useless."

"What was useless?" he asked, bristling somewhat.

"What was the last thing?" she asked in return. "A device to warn that a window was open and the rain coming in!"

"Well, burglar-catches are useful," he retorted, "and rain can do as much damage as a burglar—at least as much as some burglars, as much as a kind-hearted burglar, if it's a bad rain."

"Don't be flippant," she warned him, "or I shan't talk to you any more about this subject."

He was silent for a while, and she sat watching him as he picked at the corners of the table-cloth, moodily.

"What do you want me to do?" he asked finally.

"Show that I am not mistaken in you," she replied, slowly. "I don't like to think that I have come to care for a man who does not want to make it possible for me to marry him."

"Sometimes I believe you do care in spite of your opinion of me," he said.

"Does it flatter you that the caring should have to be 'in spite' of something?" she asked. "I believe it does."

He laughed, and shifted a bit in his chair.

"You have an uncomfortable way of hitting a fellow off just right at times," he admitted. "I do like to feel that you can care, in spite of my indisposition to perform wonderful and useful feats."

Again they sat silently for a few minutes, and then he raised his head with something like an inspiration showing in his eyes.

"I believe I have just hit on something," he said.

"Don't tell me what it is," she said, breaking in on him suddenly. "Show it to me after it's finished. I am afraid of these inspirations which get talked out and not worked out."

She added this with a half-laugh, and then went on quickly:

"You will have an opportunity in the next month to work it out without talking—at least to me. I am going away for a while—to Europe."

A look of surprise and grief came into his face.

"Why didn't you tell me?" he demanded.

"I am telling you," she replied.

"But before this."

"It has just been decided. I leave in two days with my aunt. I came with you to-day to tell you and to have this talk with you."

"I don't want you to go," he cried.

"O, yes, you do, Dickie," she said. "You wouldn't have me miss it, and it will give you the chance to do something without being bothered by me. Take my advice, Dick. Go back to the farm. Get to work with your father in his workshop. Do something. Now you must take me to the stores. I have worlds

"THERE'S DICK'S FAILURE!" HE SAID, "THERE IT IS!"

of things to do. See how much I think of you to give you all this valuable time."

II

With the somewhat unusual sensation of having a resolution firmly in his grasp, young Richard Plalonden carried it tenderly and hurriedly home, where he could be sure that it would not be lost because of his attention to other subjects. He felt more sure of himself than he ever had before, largely because something that he really wanted seemed to be dependent on his success in carrying out his determination.

Moreover, the girl had stirred up in him some vague misgivings and a certain feeling that she was right and he entirely wrong.

Wallace Plalonden, the father whose impractical nature the boy was supposed to have inherited to his detriment if not to his lasting injury, held, as the last of a once-extensive property, a small farm, where he lived in apparent contentment with his illusions, ambitions, and dreams. His past achievements gave him clear title to the name of genius. His present life showed him clearly indifferent to it. When harvesting machinery was crude, his inventions had brought it up to a high state of efficiency close to perfection. When his inventive mind was working to its best purpose, forty acres of factories sprang up around him to carry out the designs which he brought into being.

They were his, but he did not care for them. The experiment room took all of him. The office got none. There came a crash. His forty acres of factories passed from him, and were split up into a dozen different firms. His patents went to cover obligations. Still the man was as serene as if he never had known the possession of wealth.

Three times he had built up large enterprises, and had secured riches for himself; and each time, he saw them disappear and leave him close to absolute poverty.

As he grew older, his ideas became more visionary and less practical. There had been one thing about his earlier visions. They all had resulted to the practical benefit of someone, if not himself. Now he was giving the best that was in him to the design of an aëroplane, and it occupied his thoughts to the exclusion of every other project.

Horace Truesdale, father of the girl with whom young Plalonden had his talk in the restaurant, had been associated with the elder Plalonden in the harvester factories. With him he had lost everything in the crash. Slowly and with infinite pains he had dragged himself to his feet again, and, being unlike the more talented man, he watched and kept what he gained a second time.

His prejudice against his old associate in business amounted to an obsession. He could not think of him or speak of him rationally. It was his daughter with whom young Plalonden had chosen to fall in love.

On reaching the farm, Dick found his father in his workshop, cheerfully whistling as he tightened nuts on a light steel shaft carrying a propeller. Money badly needed for his own necessities and comforts had paid for the casting.

"Well, Dick," said the father, as his son came in, "back again!"

"They say at the house that you haven't had any dinner," said his son.

"Haven't I?" exclaimed the father, running a hand abstractedly through his hair. "Why, I'm sure I have. They must be mistaken."

"I'll bet they are not mistaken, and I'll bet they have been trying to get you to the table for the last two hours," said the son, sitting down on the edge of a box. "Supper will be ready in an hour. I'll see that you get in to that. Your old friend Truesdale has a brand new thing. Hear about it?"

"Has he? He always had ability in a limited way, but he lacked breadth. What is it?"

"Gasoline motor," said the young man, crossing his legs. "Say, father, what did you ever do with that combination harvester you started and abandoned? Junk pile?"

"I think so," said the elder man. "I haven't given it a thought for a couple of years."

"Could it be worked out?"

"Possibly. I didn't give it up because I was stalled, but because I lost interest. Why do you want to know?"

"Give it to me, will you? I want to put it through."

"Go ahead, Dick. Take it. I have often wished that you'd get down to something practical. I was afraid you would get into your father's habits, which are good enough for an old man who has no one but himself to please, but bad for a young man with the world to satisfy. What are you going to do with it?"

"Work it out," said the young man, determinedly and slowly. "I propose to make it run. I propose to make money. I propose to get married."

"Good luck to you, Dick," said the elder man. "I propose to make this aëroplane do some flying on new principles, but I don't know whether it will or not. You have the advantage of youth, and know that you will do what you propose to do."

A light burned in young Plalonden's room until far into the night, while he studied the designs of the combination harvester which he had with great trouble dug out of his father's stacked-up effects.

The next day found him scraping the dust and dirt and rust off the abandoned model; and from that on, the women of the Plalonden household had their domestic anxieties increased two-fold. The son was as hard to adjust to the family schedule of meals and sleeping hours as his father had ever been.

For a month the young man worked feverishly and enthusiastically, and for another month feverishly and enthusiastically at times but dejectedly at others. Three letters came to him from Miss Truesdale—one from London, one from Paris, and one from Naples. Each produced a week of redoubled effort on his part, followed by a reaction during which he deserted his workshop for long country walks.

The elder Plalonden nursed his aëroplane with the pride of an artist and the care of a dentist. It was during one of the son's moody spells toward the end of the second month, that a brisk and apparently busy visitor came to see the elder, and found him in his workshop.

"My name is Wilson," he said, introducing himself. "I'm in the circus business. I have heard that you have an airship that will work, and that it is about completed. What will you take for it?"

"Nothing," said Plalonden, promptly.

"Say $10,000 if it's ready soon and will work," suggested Wilson, smiling.

"You have made a fair offer, and I suppose you are entitled to a fair answer. I won't sell because the aëroplane as it stands now is no good. It will operate, but so will a dozen others which have been made. If it can't be made to operate usefully and commercially, I have no interest in it. It will do that the way it stands. It might serve your purpose. It probably would. You could use it for exhibition purposes, but I have no interest in invention for that purpose."

"That's your final decision?" Wilson asked, looking at the inventor sharply.

"Final," said Planonden.

"I'll leave my card anyway," the circus man said, as he turned to go. "I can't say that the offer remains open indefinitely; but still, if you change your mind, let me know."

An hour after his departure, Dick came into his father's shop and sat down moodily on the edge of a box.

"What's the matter, Dick?" the elder Plalonden asked.

"I'm discouraged."

"Any reason?"

"Plenty."

His father looked at him inquiringly, and the young man let it out in a burst of words.

"Miss Truesdale will be home in six weeks. I have been stalled on what ought to be a simple part of the machine. I might get it; but suppose I do. Where shall we find money to have it cast? What's the use?"

His father looked at him a moment apprehensively, and then said, kindly:

"Go away for a while, Dick. If you stick too close to a thing, lots of little things get to look like big ones. Go away for a couple of weeks, and then come back to it. You will find you can make it all right then."

"I'm going away to-night. But suppose I can get over the trouble—it's only a matter of shifting levers—how does that help us? It will not make us any richer."

That night, after his son, with his baggage, had made a moody departure from the house, the elder Plalonden took a

lamp into the workshop, and went over the young man's designs carefully.

"He has it nearly done," he said to himself, as he examined the model. "Here's where he was stuck on the levers."

Next morning the old man went again to the shop and turned to his aëroplane. He did not resume work on it. He merely took a chamois skin, and rubbed its shafts and polished steel. Then he sat for a long time and looked at it. He walked around it, and studied it reflectively.

Finally, he fell into a profound and abstracted contemplation of a cobwebbed corner of the shop and was motionless for an hour. When he aroused himself, he went slowly and seemingly in sadness to his table and wrote three letters.

One was to Wilson, the show man. The second was to one of several capitalists in New York who had reason to know that when Plalonden pledged his word to an invention that invention was right. The third was to the firm which made his castings.

Dick came home at the end of two weeks, refreshed and more hopeful, and fell to work again on his design. His father watched him curiously, but offered no advice. At the end of a week the young man announced that the levers which had bothered him were found.

"The discouraging part about it was that they were the simplest parts of the whole thing," he said, laughing.

A day afterwards he was surprised to find his father taking the aëroplane to pieces; and the following day more so when a dray drove up to the farm and his father superintended the removal of the airship.

"What's this all about, dad?" he asked.

"We're just taking it away to give it a trial," said the elder inventor, shortly.

In another week he had finished his model, and had made an important alteration to the original. He explained this to his father enthusiastically, and the latter listened to the explanation with a puzzled and not altogether overjoyed expression on his face, although he agreed that the alteration was a decided improvement. The next day that part of the model had disappeared mysteriously; and Dick, grumbling over the careless misplacing of it, was not able to get much satisfaction out of his father.

He replaced it with another, and then, with his invention completed, he fell into moodiness again. There was no money for the casting, and none to be had.

In spite of his own disturbed state of mind, he could not help observing the behavior of his father, who walked nervously about in the shop from which the aëroplane had been taken, for all the world like a hen which has been deprived of its chickens.

Dick attempted to question him as to the fate of the machine, but could get no satisfaction.

The two made a curious pair in the succeeding days—the young man the prisoner of his hopelessness, and the old man the victim of his abstract sorrow. Then came a letter from Miss Truesdale. She had landed in New York, and would be at home in twenty-four hours.

"Of course you'll see her, Dick," said the father.

"No," said the young man, shaking his head. "She said she wanted to see results and not to hear promises. I have no results to show."

In consequence of this, the elder Plalonden wrote another letter. In three days he handed the answer to his son.

"She will be here to-morrow morning," he said. "Now, you will have to meet her at the station and drive her out."

"You get ahead of me every time, don't you, dad," exclaimed the young man, laying his hand on his father's shoulders. His face had brightened up, and he smiled as if supremely happy to be defeated in his resolution.

He met her the next day as she stepped from the train.

"Why did I have to come to you?" she asked, as they drove along the country road.

"Because I have failed," he said simply.

She turned away her head for a moment, but presently looked at him, smiling a bit soberly.

"There still is time," she said; but Plalonden shook his head.

"You make me feel as if I were turning against you because you think you have failed," cried the girl impulsively. "I am not. I refuse to be convinced that you will not show your worth. I am almost tempted to be a weak character

and say that I don't care whether you do or not."

She turned away her head again for a moment; but he did not answer, and they drove into the home driveway in silence. Suddenly they were aware of a clicking metallic sound from a field hidden by a clump of trees. This stopped, and there was a moment's silence, followed by a cheery hail:

"O, Dick, come here!"

The young man helped the girl to alight, and led her toward the field. It was of corn, with wheat full-ripened in the adjoining one. A section of the dividing fence was down; and Dick's father, seated on a new harvester, was driving from the wheat to the corn. Dick stood as if held to the ground; and the girl, more mystified and equally motionless, stood by his side.

Throwing a lever, the elder Plalonden took off an edge of the green standing corn, and the bundles were thrown out at the side. Shifting the levers at his side again, he turned into the weeds; and they, like the corn, were mowed down. Without leaving his seat, and with merely a change of levers, he drove again into the wheat, and the bundles of grain were tossed out. Then he gave a cheer and sprang down, running to the girl with outstretched hands.

"There's Dick's failure!" he said. "I know he told you it was a failure. There it is!"

"Father!" was the only word the young man had at his command, and that was tremulous.

"Don't stand here," said the old inventor, bustling them along. "There's better news than this. Come to the house and I'll show you a letter."

Almost at a full run he rushed them to the house. Then he bolted within, and in a second was bolting out, quite as precipitately, waving a letter triumphantly in his hand.

"Here's the promise of all the capital you need," he shouted. "O, yes, Dick's quite a failure!"

At that moment a bell was heard ringing in the roadway. They turned in the direction of the sound, and saw a wagon carrying an enormous canvas sign approaching, its coming heralded by the monotonous beating of a gong. As they looked, it came abreast as they read:

WILSON BROTHERS GREAT
UNITED CIRCUS
UNPARALLELED ATTRACTION
PROFESSOR PLALONDEN'S
AËROPLANE
TWO ASCENSIONS DAILY

There was more of it, but that was sufficient; and as the moving canvas signboard which was advertising the circus along the country roads passed on, Dick turned to his father, and put a hand on his shoulder.

"Father!" he exclaimed. "Did you even do that?"

The elder Plalonden had unconsciously twisted his face into a wry grimace as he saw the sign, but he took the girl's hand in his right and the young man's in his left.

"Shucks," he said, a little brokenly. "This is worth more than that costs."

THE EARTHQUAKE

By HENRY M. HYDE

I

Man scratches little runways in the dirt,
And raises tiny mounds of stone and steel,
To tease the microscopes of curious gods.
Sends feeble ships to tempt the awful deep,
Plucks one red feather from the lightning's wing,
Then lifts himself in petty human pride
And boasts his lordship over all the world.

'Till Earth—his Mother Earth—
Olympus shakes with laughter at the claim—
Tired of these vermin that infest her skin,
Stirs her vast bulk and in an instant's pause,
Man and his work are leveled with the dust,
In ruin absolute.
'Tis proved, in Nature's plan
How small, how poor, how mean a thing is man.

II

Out of the ruins crawls a frenzied wretch,
Creeping on crutches from the death that flies,
Pallid with terror, whining in brute fear,
Hugging in impotence some tawdry toy.
Blackened and bleeding wins a little height,
There halts to view the chaos left behind—
A lifetime's labor turned to smoking waste

Then, as he stands, there comes a potent change—
The god-like will, stronger than earthquake's shock,
Lifts high his cowering head and takes command.
While from his blood-shot eyes there looks a soul,
Deathless, undaunted in the face of doom,
Majestic in defeat.
Higher than Nature's plan,
How great, how strong, how proud a thing is man.

BEFORE THE EARTHQUAKE.
Looking down Market Street, San Francisco's Principal Business Thoroughfare.

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FIRE SWEEPING THE BUSINESS DISTRICT ON APRIL 19TH.
Hayward Building at left, Merchants' Exchange in center background, and Mills Building at right.

AFTER EARTHQUAKE AND FIRE HAD DONE THEIR WORK.
Ruins at Market and Main Streets. Regular soldiers on guard. On placard at right an enterprising glass company announces opening of a temporary office in Oakland.

SAN FRANCISCO BURNING AFTER THE EARTHQUAKE.
Comparatively little damage was done by the shock. The fire was by far the most destructive.

WHAT SHOCK AND FIRE DID TO STEEL GIRDERS.
Skeletons still standing, with everything else burned away.

A STUDY IN CONTRASTS.
Steel skeleton sky scraper, at right, gutted, but still standing. Masonry construction, at left, a tottering ruin.

THE GREAT FERRY BUILDING.
The Front Door of San Francisco. Railroads, Steamers and Street Car Lines All Center Here.

THE EXODUS AFTER THE EARTHQUAKE AND FIRE.

The great Ferry Building, preserved from destruction by most desperate efforts, was the point towards which the terrified inhabitants fled for safety. Refugees were taken by boat to Oakland. Note how pavement was torn up and street car rails twisted by the shock.

SAN FRANCISCO'S CITY HALL BEFORE THE SHOCK.
This great structure, costing $7,000,000, was one of the boasts of the city.

CITY HALL DURING AND AFTER THE FIRE.
The larger photograph was taken while the flames were at their height. The smaller shows the ruins after the smoke had partially cleared.

JEFFERSON PARK.

To these open spaces the people fled at the first alarm and many are still living there in tents and under the open sky.

COPYRIGHT, 1906, BY [illegible]

AFTER THE REFUGEES MOVED IN.

Scene in one of the parks, where rich and poor are living side by side in tents and huts. A true return to the simple life.

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WATCHING THEIR HOMES BURN.

Resistless fire sweeping a residence street, while the owners, surrounded by rescued household goods, look on in impotence

WHY SAN FRANCISCO BURNED.

The earthquake caused great fissures in the street, breaking the water mains and gas pipes, making fire certain and the efforts of the fire department futile. The house in the upper left hand corner has sunk one full story into the ground.

WHAT THE EARTHQUAKE DID TO OLD FRAME BUILDINGS.
Wreck of Valencia Hotel, in which forty people were crushed to death.

THE SHOCK AT SAN JOSE.

At some points outside San Francisco the shock was greater than in the city of this house. Several people were killed in the ruins

EFFECTS OF EARTHQUAKE ON PAVEMENT AND STREET CAR TRACKS.

Remarkable scene in front of new post-office, Seventh and Mission Streets.

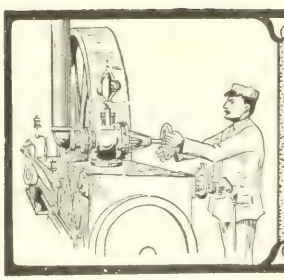
OLD DOLORES MISSION, LEFT STANDING.
This ancient structure, built 130 years ago, was uninjured, while the modern cathedral, immediately adjoining, was destroyed.

THE PRESENT PROBLEM.

San Francisco is settling itself to tear down these ruined walls and raise a prouder city in their stead.

WORK FOR THOUSANDS.

For months the men who can wield pick and shovel will be more important in 'Frisco than any other class of citizens.



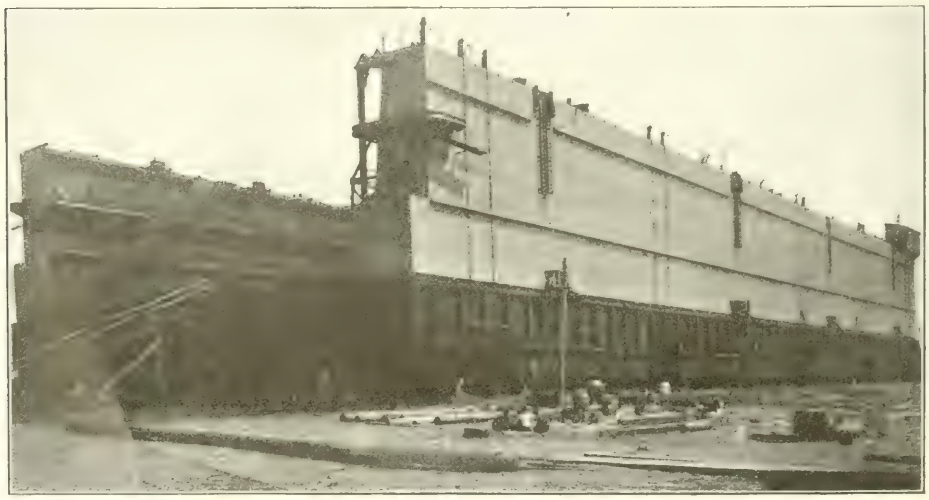
ENGINEERING PROGRESS

Chinese Dry-Dock

UNDER orders of the German Government, an immense, iron, floating dry-dock has been constructed at Oberhausen, Germany, for use at Tsing-tau, China, for the accommodation of the German Navy and mercantile marine. This dock has a bearing capacity of 16,000 tons, or about 2,000 tons more than the weight of the largest armored vessels in existence. It is 410 feet in length and 114.8 feet in breadth externally, the inner room intended for receiving the ships being 98.4 feet in breadth at the bottom and 108.24 feet on the top. The height from the bottom to the upper lateral decks is about 62.32 feet. The pontoon of the dock is composed of 5 separate sections connected with one another by lateral tanks running throughout the length of the structure. Each of these individual pontoons contains two gigantic pumping plants, the whole being able to raise the dock when loaded with a ship, from the lowermost position, in about two hours. Electrical current supplied from the shore is used to operate the pumps. The illustration shows the dock while on the building slips.

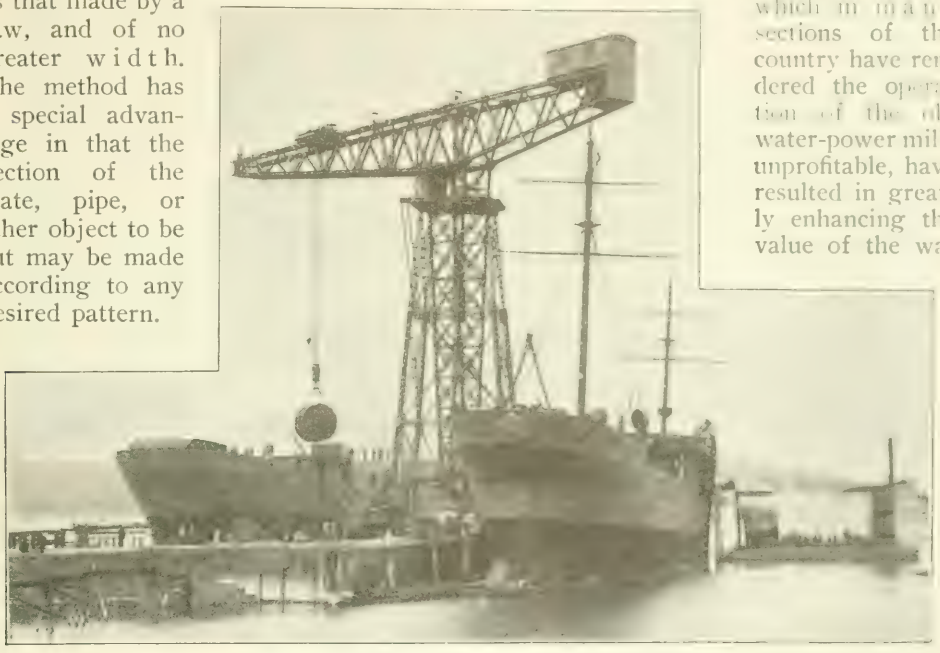
New Method of Cutting Steel

SAWING steel is a dangerous process because of the great power required in running the cutting tools in the case of tempered metal, and also because of the small particles of steel which are scattered through the atmosphere and breathed into the lungs of the workmen. French engineers have recently devised a method of cutting steel which avoids these dangers. A small jet of oxygen gas is the instrument employed, and has proved itself most efficient. The complete apparatus comprises two pipes, which move along the mark to be cut. From the first pipe issues a jet of



DRY-DOCK BUILT IN GERMANY FOR USE AT TSING-TAU, CHINA.

mingled oxygen and hydrogen, producing a flame which first heats the metal red-hot. The oxygen jet issuing from the second pipe literally burns away the heated metal. The cutting is very quickly done, the heat not having time to be dissipated, and no fusion of the metal taking place. The section is as clean as that made by a saw, and of no greater width. The method has a special advantage in that the section of the plate, pipe, or other object to be cut may be made according to any desired pattern.



GIGANTIC HARBOR CRANE AT WORK.
Transferring large marine boiler from one vessel into hold of another under construction.

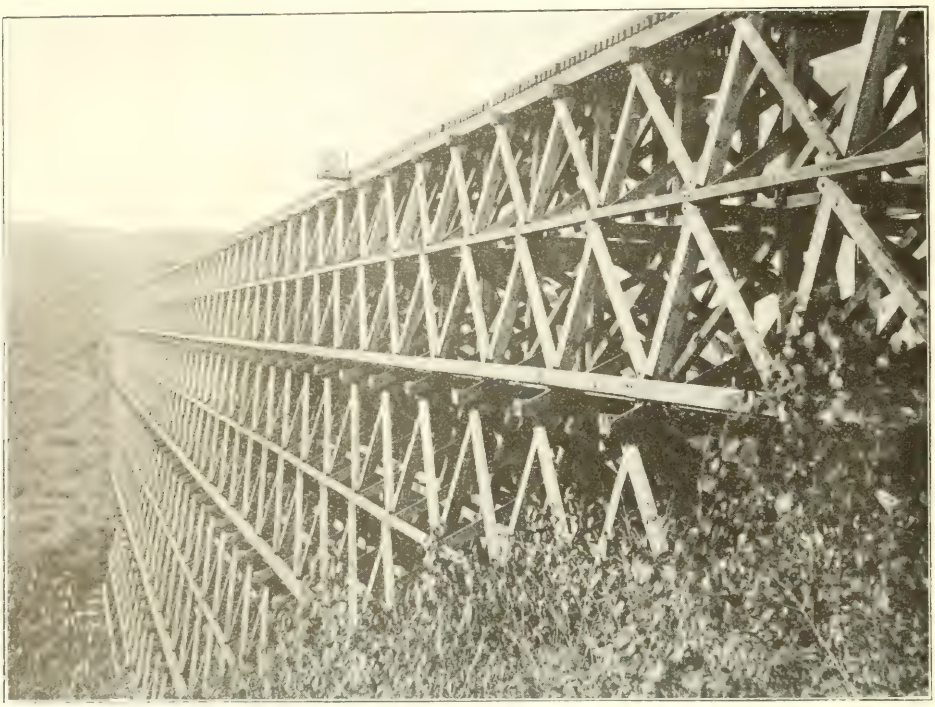
Mammoth Harbor Crane

ELECTRICALLY-driven cranes are rapidly finding their way into every field of application, and it is safe to state that before long both steam and hydraulic cranes will largely be supplanted by them. The actual development of electric-crane building is mainly due to the active co-operation of electrical and mechanical engineers. Especially in Germany has this branch of engineering construction been given special attention. Cranes able to lift loads up to 150 tons, while being susceptible of rotary movements, have been designed there for use in large seaports in connection with the loading and unloading of great ocean liners, which work must be done in as short a time as possible in order to save the great loss occasioned by the temporary idleness of ships, which represent investments of millions. A week's delay may represent a loss of thousands.

Value of Water Powers

IT is an ill wind that blows nobody good. The same changing conditions which in many sections of the country have rendered the operation of the old water-power mills unprofitable, have resulted in greatly enhancing the value of the water powers themselves. In the early development of this country, it was the water powers which perhaps more than any other single factor determined the location of industrial centers, especially in the East and Middle West. At these points the first flour and lumber mills were erected, and around them the villages and towns were built up. As soon, however, as the country began to fill up and railroads were built, other factors besides cheap power came into play in determining the location of industrial centers. The result has been that many of the old mills with good water powers have ceased to be profitable and have been partially or wholly abandoned.

The remarkable development, however, of electrical transmission in recent years has wrought still another change,



BELLEVUE TRESTLE OVER GOULAIS RIVER, ONTARIO.

On line of Algoma Central Railway. A single-track bridge, 1,510 feet long, 169 feet high. Said to be the longest wood trestle railroad bridge in the world.

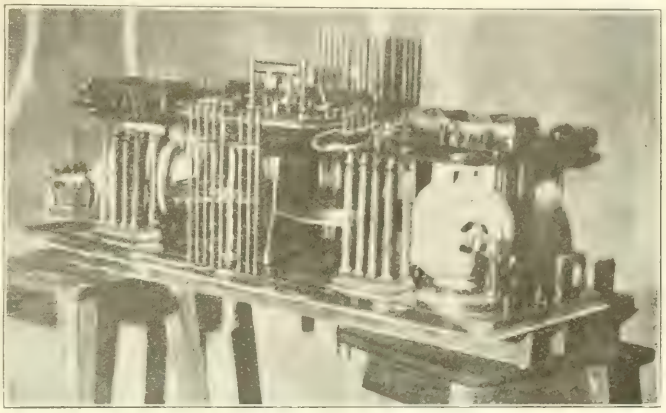
and many of these water powers that had fallen into desuetude have been again clothed with great industrial value. Many of them that formerly operated flour mills are now lighting nearby villages, operating trolley lines, or supplying power for other purposes; and it is perhaps no extravagant flight of imagination to predict the time when every brook and rill now wasting its energy will be harnessed and put to some valuable economic use.

A Great Trestle

THE Algoma Central & Hudson's Bay Railway is one of the great projected enterprises of the Clergue Syndicate which was undertaken in the palmy days of the big power company at the Canadian Soo. Like all the undertakings of that company, it was begun on a great scale of costly construction, everything being the best. There were ninety-pound steel rails, stone ballast, superb equipment, 100-ton locomotives, etc. The road was to have for its northern terminus James Bay, and to pass through some of the wildest and most picturesque scenery on the American continent. At the point from which the accompanying view was taken, the road approaches the Goulais river, to span which this handsome wooden trestle was built, covering a length of over 1,500 feet, and rising at its highest point, 169 feet above the river bed. The valley stretches westward to the mouth of the river, which empties into Lake Superior, some twenty miles away, whose waters, on a clear, bright day, can be seen sparkling in the sun. The Laurentian Mountains are also a prominent feature of the landscape; and the view from the top of the trestle is unsurpassed for bold yet quiet loveliness, the silver thread of the Goulais meandering through the wooded valley, now and then hidden by bold bluffs, then reappearing a foaming little rivulet.—J. M. Bulkley.

Long-Distance Control of Ships

ENDEAVORS have been made quite recently to transmit electrical energy for power purposes without the intermediary of any conducting wire. Instead, however, of transmitting large amounts of power to be used at the receiving station for the performance of a given operation, it will be found advantageous in many cases simply to have the wireless outfit operate a relay actuating a local circuit at the receiving end, by means of which the desired work may be performed. The starting or stopping of motors is thus effected by an apparatus designed by Professor Branly, to whom the invention of the principle underlying wireless telegraphy is due.



THE TELEKINO.
Apparatus for long-distance, wireless control of moving ships, balloons, etc.

A still more interesting apparatus has recently been constructed and tested by a Spanish engineer, Mr. Torres Quevedo of Bilbao. This in intended for automatically actuating the screw and rudder of a boat, which may thus be steered from the shore in exactly the same way as by a pilot on board. The apparatus may also be used for steering a balloon or airship from the land, and for a multitude of other purposes. The "Telekino"—as the device is called—comprises two parts: First, an ordinary wireless telegraph outfit, for transmitting Hertzian waves over long distances; and Second, the apparatus actuated by the electric waves (the "Telekino" proper).

Tests were made at the wireless telegraph sending station of the Spanish Royal Marine Club at Bilbao. A boat contained the receiving station, the aërial of which collected the electrical waves, transmitting them to a small tube filled with filings. These filings, becoming conductive, allowed the current to pass, causing an electro-magnet to oscillate. A small oscillation on board the boat thus corresponded to each spark given off from the land station.

The Telekino proper consists of 3 electro-magnets in addition to the mechanical pieces serving to actuate the screw and the rudder. While the central electro-magnet reproduces the signals, the two remaining ones serve to effect the various operations. The inventor is bestowing special care on reinforcing and increasing the oscillations occurring in wireless telegraph outfits, storing this motive force in special accumulators provided with two branches that lead to the screw and rudder respectively. The whole operation thus consists in opening or closing the two circuits. The oscillations produced in the central electro-magnet act on a small escapement wheel, advancing by one tooth at each oscillation so as to open or to close the circuits. By an ingenious mechanism, the various parts of each electro-magnet, after accomplishing the motion controlled by the sending station, return to their initial position so as to be ready to work anew.

From the club station Torres Quevedo made his boat perform quite a number of operations in various directions with surprising accuracy. It is believed that the Telekino can be applied to the prevention of shipwrecks as well as to the defense of marine places without any risk of human life.—DR. ALFRED GRADENWITZ.

To Cross Atlantic in Five Days

By HENRY R. HUNTER

MUCH the largest and most powerful ship in the world will be launched next July in the shipyards of John Brown & Company, Clydebank, Scotland. She is building for the Cunard Steamship Company, which also has under contract a sister ship, which will be floated in September at the yards of Swan, Hunter & Wigham Richardson, at Wallsend-on-Tyne. The new Cunarders will bring back to England and to their company "the blue ribbon of the seas," now held for both size and speed by the Germans.

The enormous size and vast power—undreamed of a few years ago—of the new turbine Cunarders may best be gathered by comparing them with the other great ships of the world—including the *Great Eastern*, that monument to the genius of a man who was ahead of his age:

World's Largest Ships

	Length over all.	Beam.	Depth.	Displacement in Tons.	Horse-Power.	Speed knots per hour.
	ft.	ft.	ft.			
Great Eastern	692	83	57½	27,000	8,000	14.25
Lucania	625	65	42	19,000	30,000	22.01
Oceanic	704	68	49	28,500	28,000	19.50
Deutschland	686	67	42	23,000	37,500	23.5
Baltic	725	75	49	40,000	18,000	16.25
Kaiser Wilhelm II	706	72	52½	30,000	40,000	23.5
New Cunarders	800	88	60	43,000	80,000	25

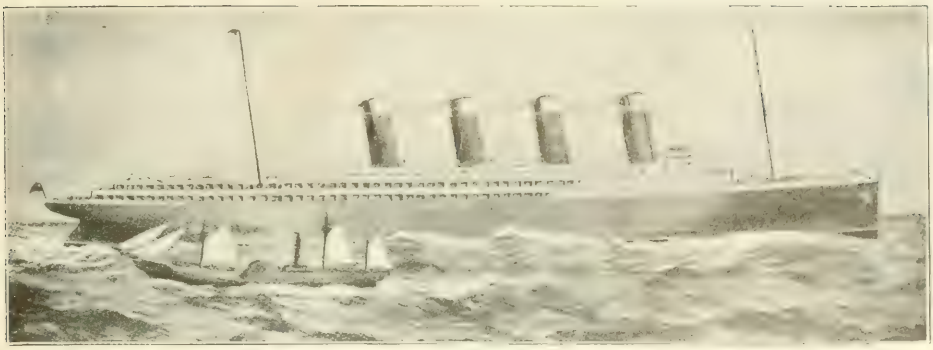
LARGEST CABLE

A length of 3¾-in. cable for the new Cunarder. Total length of main cable, about 2,000 feet. Weight about 100 tons. The spring anchor shackles weigh respectively 4½ and 7½ hundredweight.

Until the building of these latest ships, the *Great Eastern* had always held the record for depth and beam, though surpassed in length. The new Cunarders, which are to be christened the *Mauritania* and the *Lusitania*, are 2½ feet deeper and 5 feet wider than the older leviathan.

But it is in the matter of power that they far outclass everything heretofore built. The *Kaiser Wilhelm II* at present holds the record for speed across the Atlantic, having made the trip at an average rate of 23.5 knots per hour. Its engines generate 40,000 horse-power. So vast an increase in power is required to slightly increase an already high speed, that to enable the new Cunarders to make 25 knots an hour, it has been thought necessary to install Parsons turbine engines of 80,000 horse-power, thus doubling the capacity of the *Kaiser Wilhelm's* power plant. In other words, after a speed of 23.5 knots has been reached, at a cost of 40,000 horse-power, the horse-power must be doubled to gain less than 2 knots more. The famous *Great Eastern* made 14.25 knots with 8,000 horse-power. It has been necessary to multiply the power by ten in order to get less than twice the speed.

The two new ships are as high, on an



HOW THE NEW CUNARDERS WILL APPEAR WHEN COMPLETE.
Small vessel shows relative size of first trans-Atlantic Cunarder.

even keel, as an ordinary eight-story building. If stood on end, they would tower up into the air 245 feet above the top of the Washington Monument. The only fabric ever built by human hands which would overtop them, is the Eiffel Tower. The new ships have eight decks each, all connected by electric elevators. They have accommodations for 1,000 first- and second-class passengers, and for 1,200 in the steerage. The crew of each will include 800 men.

When I Am Dead

By Sir Lewis Morris

WHEN I am dead and turned to dust,
Let men say what they will, I care not aught:
Let them say I was careless, indolent,
Wasted the precious hours in dreaming thought,
Did not the good I might have done, but spent
My soul upon myself—sometimes let rise
Thick mists of earth betwixt me and the skies;
What must be, must.

But not that I betrayed a trust;
Broke some girl's heart, and left her to her shame;
Sneered young souls out of faith; rose by deceit,
Lifted by credulous mobs to wealth and fame;
Waxed fat while good men waned, by lie and cheat;
Cringed to the strong; oppressed the poor and weak;
When men say this, may some find voice to speak,
Though I am dust.

WHERE HISTORY

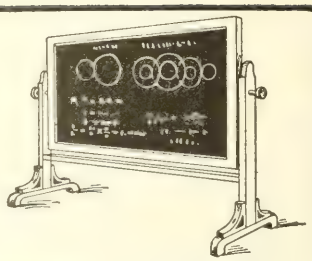
Old Christ Church, Alexandria, Virginia. A spot sacred with associations of the Wars of the Revolution and the Rebellion. Here both George Washington and Gen. Robert E. Lee worshiped.

WAS MADE

Monument at Yorktown, Virginia, marking spot where the British commander, Lord Cornwallis, surrendered to George Washington, October 19, 1781. This act virtually closed the Revolutionary War, and forever established American independence.

CHALK TALKS

by CARL S. DOW.



Number Twenty-Eight—The Camera

"YOU press the button, we do the rest." While a few people are so busy or so indolent that they are content with pressing the button and letting someone else do the rest, the average beginner sooner or later wants to do the rest himself. In fact, the successful, persistent amateur is always the one that does the rest, for the various mechanical and chemical processes of making a picture are in most cases of greater interest than the pressing of the button.

But what is "the rest?" It may be defined as the making of the negative, and then the finishing of the photographic print. In photography, a negative is a thin film of gelatine having transparent portions, opaque parts, and some areas midway between, or *tones.* It is called a *negative* because the colors —or, rather, the shades—are reversed; that is, white and light-blue objects appear black or nearly opaque, while deep shadows or black portions are represented by transparent areas.

Pressing the Button

Pressing the button, or "making the exposure," is the act of admitting light to the dark box, called the *camera,* which light affects chemically the substances of which the film of the dry plate is composed. It is not only possible but practicable to make a picture by admitting light through a pin-hole; but one of the chief drawbacks to this method is the great length of time required. A lens substituted for the pin-hole makes it possible to shorten the exposure materially by collecting and condensing the rays of light and arranging them on the dry plate.

Although the lens is the most important part of the photographic outfit, few have opportunity to study its complex principles; and although a thorough knowledge of optics is not necessary to the making of satisfactory pictures, yet a few principles should be understood.

The diagram on the blackboard shows the direction of the rays of light passing from the image into the camera. For instance, light from *A* passes through aperature (or lens) at *O,* and thence to the plate at *B;* similarly, light from *C* passes to *D.*

This diagram shows why the image is inverted on the ground glass; and a similar diagram would show why objects at the right-hand side of the picture appear at the left when one looks at the ground glass. From this is seen, also, why the field of the camera dry plate is limited in extent, and the reason for placing the camera at considerable distance when high buildings are being photographed. A ray of light from a point above *A,* such as *Y,* in passing into the camera does not strike within the boundary lines of the plate. The remedy for this is to go back far enough to have the image from *C* to *Y* so reduced in size as to be entirely within the limiting edges of the ground glass; or, raise the lens a little cutting off the picture just above *C.* Sometimes one method is preferable, sometimes the other.

Focus

A ray of light from any point, such as *E,* passes through the lens, and is sharply defined at some point *F,* the distance from *O* to *F* depending upon the shape and character of the lens. If the ground glass *B D* is at a greater or a

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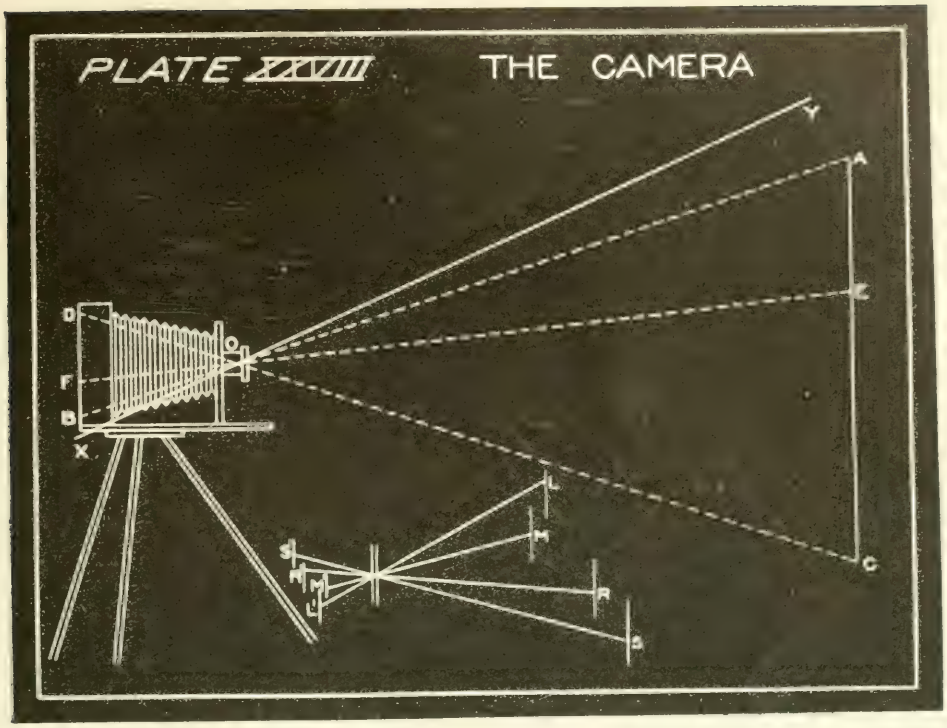


less distance than this from the lens, the image thrown upon it will not be sharp. The correct position is found by trial; and it is a very simple matter if all points of the image are in the same plane, as in *A C*.

Suppose the landscape has important points in many different planes represented by lines passing through *L, M, R,* and *S*. Evidently all will not be perfectly defined on the ground glass when in any one position, because their focal distances are found to be at *L′, M′, R′,* and *S′*.

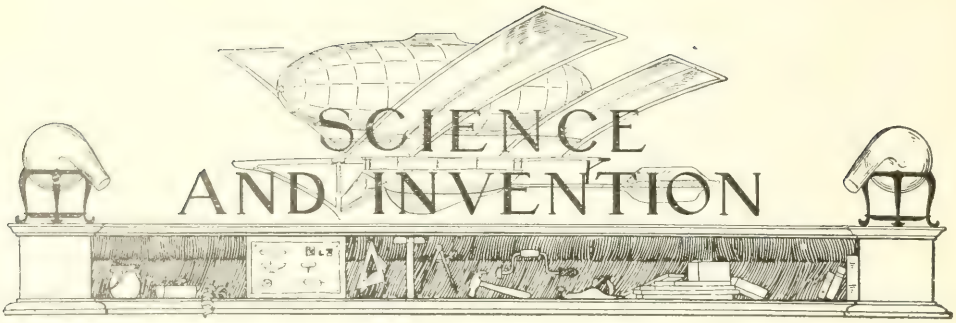
What is to be done in this case? By *stopping down* the lens—that is, by decreasing the size of the opening through which light passes—the points on the ground glass will be sharper. It is customary to focus on the most important object, or, if there are several objects of special importance, find the extreme positions of the ground glass, and then place it midway between them. These differences in distance are greater or less according to the kind of lens used. With a *wide-angle* or *short-focus* lens, the variation is slight; but this lens is slower than the *long-focus,* the perspective is not so good, and it is liable to cause distortion at the edges of the plate. Its chief value is for interiors and cramped places. If but one lens can be purchased, it is better to select a long-focus.

Exposure

Assuming that the camera is in position, focused, and the plate-holder slide drawn, the next move is the exposure of the plate; and many an amateur has asked, "How long?"

The time of exposure depends upon so many factors that experience only will enable one to get good results, although many attempts have been made to produce tables, etc. Plates vary in rapidity or sensitiveness; but a medium speed is best for most work, because it is fast enough to require but a short exposure, and it has more "latitude" than a very fast plate.

For marine views, snow scenes, and pictures made in the middle of the day in summer, a very short exposure should be made—usually under one second. Interiors, pictures in the shade, and pictures of dark objects, require much longer time. In photographing machinery, which is usually black, a soft interior light and a slow plate is best, the exposure requiring three to five minutes. If there is danger of undesirable reflections from polished parts, a few dabs of putty on these parts will overcome the difficulty; the putty can be removed with benzine or gasoline.



A Unique Clock

OUR poorhouses afford many pathetic instances of the loss of livelihood through the onward progress of mechanical invention—men of expert skill acquired perhaps through long years of training, now cast aside as useless tools, supplanted through the more efficient devices of automatic machinery and other triumphs of modern invention. Such has been the life-story of Louis Julien, a Frenchman, now an inmate of the Northampton County Poorhouse, near Nazareth, Pennsylvania. Like his father and grandfather before him, he was a clockmaker, and for many years earned a comfortable living at his trade in Belgium, and later in the United States. In time, however, he realized what perhaps all skilled artisans must in time realize—that men are not machines, cannot compete with machines, and must in the end cease to do any and all sorts of work of which machines are capable.

LOUIS JULIEN AND HIS WONDERFUL AUTOMATIC CLOCK.

This lesson is a hard one, and it was none too easy on Louis. Seven years ago he was forced to go to the almshouse. Here he has made himself generally useful at odd jobs of repairing.

During his spare moments in the past five years, he has constructed an eight-day clock which is a marvel of mechanical ingenuity. It has second, minute, and hour hands, and a dial showing the days of the week and month, and the signs of the zodiac. In a separate apartment are shown the rising and setting of the sun and moon. In addition to the hours, the quarters, half-hours, and three-quarter hours are struck. And in the darkness of the night, or if a blind person wishes to consult the clock, the time may be ascertained by pulling a cord, whereupon the hour will be struck at once, followed by whatever quarter-hour it may then happen to be. But perhaps the most interesting feature of the clock is the work done by a great number of automatons. At Christmas time the advent of the Christ is shown, the manger, and the oxen and asses in their stalls. The Wise Men come from the East; and an angel appears to warn the parents of the plot of Herod. Joseph places Mary and the Babe on an ass, and they flee into Egypt. Herod and his soldiers arrive only to find their intended victim gone.

The clock is run by weights, and in its mechanism the "parts" of three timepieces are used.—GEORGE F. KUNKEL.

Kites in Wireless Telegraphy

PROF. ALEXANDER GRAHAM BELL has attracted much attention in recent years through his experiments with tetrahedral kites, which have marvelous lifting power in proportion to their weight and dimensions. An important test of the application of these kites to wireless telegraphy was made on March 27th at Arlington, Virginia.

It is known that one of the greatest difficulties in sending messages across the ocean and over mountain ranges is concerned with the raising of the antennæ to a sufficient height to pick up the transmitted Hertzian waves. It is thought that with the help of kites of the tetrahedral pattern sent up from steamers along the ocean track, the difficulty may be overcome.

For the purpose of the test, Professor Bell loaned one of his largest kites, having 230 cells. This was sent up 2,000 feet; and from antennæ 400 feet long, messages were caught and transmitted down over a steel wire. Messages were received from the government wireless station at the Washington Navy Yard, from the De Forest station at Galilee, New Jersey, and from a steamer 100 miles out from New York and over 350 miles from the scene of the test.

FORE-AND-AFT SECTION OF SLIDER.

Sliding Motor-Boat

FRENCH designers have recently put into service a peculiar model of motor-boat designed to slide over the water instead of cutting through it. As will be seen from the accompanying section, this result is achieved by the peculiar shape of the under part of the vessel, which slopes backward slowly from the bow to a maximum depth at about the center of the craft, somewhat like the smooth under surface of a saucer.

In general appearance this new motor-boat is not unlike a submarine. It is built of steel plates, and has been found to pitch and roll but little under swells and heavy seas. It is 39⅓ feet long, 9 feet 10 inches beam, and 5⅓ feet draft, displacing about six tons. With 4 cylinder engines of 66 horse-power at 400 revolutions per minute, it has made a speed of about 13 knots. A speed of 32 knots, it is believed, can be made by a boat of this type with less beam and draft and more powerful machinery.

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TETRAHEDRAL KITE USED IN WIRELESS TELEGRAPH EXPERIMENTS.

TORPEDO-LAUNCH "DRAGONFLY" AT FULL SPEED.

New Torpedo-Launch

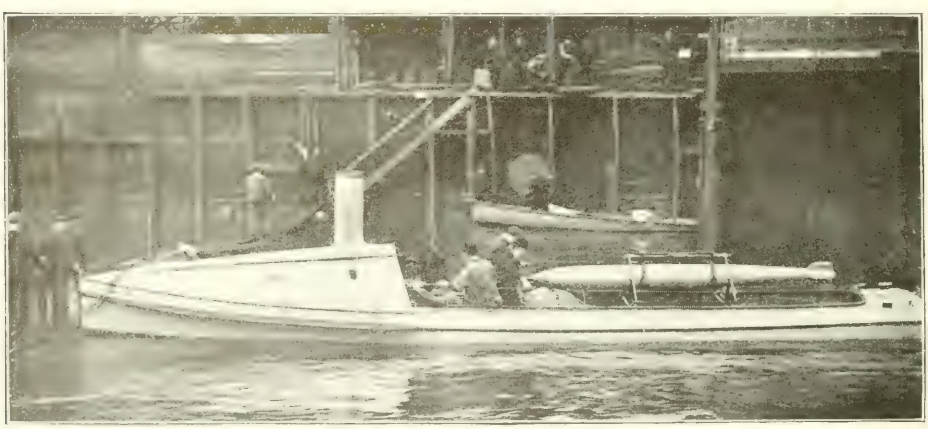
THE 40-foot torpedo-launch *Dragonfly*, recently constructed in England, is the first of an interesting new type of war craft designed to operate at a speed of 18 knots an hour. It is built to carry a 14-inch Whitehead torpedo, which is lowered over the side by means of a specially designed side drop gear. The body is first directed bow-on in the direction of the object which it is desired shall be destroyed, and then launched.

This torpedo-boat is propelled by a 120-horse-power gasoline engine, and is of 8,500 pounds' displacement, with a draught of 2 feet 7 inches, and a beam of 6 feet 2 inches. The boat is built of galvanized mild steel and is provided with a water-tight bulkhead so that it will not sink even if it sustains a damage to the stem, while it also has a very broad stern, which is said to overcome any difficulty as to stability when launching the torpedo over the side.

The accompanying illustration shows the arrangement of the torpedo on the craft. The turtle-back deck arranged in the bow extends as far to the rear as the after end of the engine, and is a portable piece carried over the engine to protect it from the weather. The steering wheel and reversing lever are located on the port side, and detachable spray guards are so placed as to prevent the splash from the bow waves being carried into the launch. The fuel tank holds 100 gallons—enough, it is claimed, to operate the launch for a period of ten hours.

The engine is 4-cylinder, operating at a speed of 900 revolutions per minute. The cylinders have 8-inch bores and a stroke of 8 inches.

The engine weighs about 2,500 pounds, or at the rate of 23.25 pounds per brake horse-power. It is maintained that there is very little vibration even at a speed of 900 revolutions per minute, as the engine is of very light construction and is very carefully and exactly balanced as to its moving parts. This is most essential—in fact absolutely necessary—on account of the very light construction of the hull, in order to insure very high speeds and effectiveness in service. The engine is started by means of compressed air contained in a reservoir placed in the stern of the launch. A small Brotherhood compressor is provided, for supplying the necessary air pressure, driven by a Thornycroft single-cylinder oil engine of 6 horse-power capacity.



THE *DRAGONFLY*, A 40-FOOT TORPEDO-LAUNCH.

A new type of fighting craft added to the British Navy.

TRACK-LAYING MACHINE AT WORK.

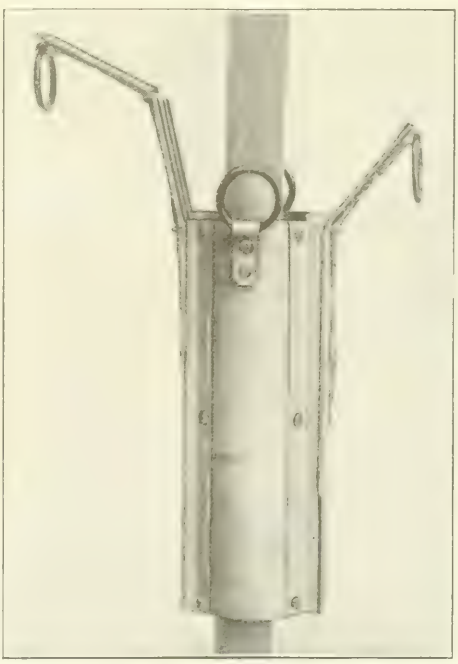
Track-Laying Machine

ONE of the new things in connection with railroad construction, is a track-laying machine—one that does its work well and rapidly. This machine was recently invented by Mr. L. M. Luckens, Master Mechanic for the McCabe & Steen Construction Company, and is now being used in laying track, at the rate of three miles per day, on the extension of the St. Louis, Brownsville & Mexico Railroad. It is run by a 20-horse-power single engine, the steam being supplied from a locomotive by means of a pipe line. The machine itself is 70 feet in length, and is 18 feet high. Connected to it are 13 trams, each being 11 inches wide and 35 feet wide long, which move continuously by means of an endless chain to carry ties on star-pointed rollers to the front of the machine. The device is a great labor-saver, and is capable of doing the work of a large force of men. From the accompanying picture, the *modus operandi* can very readily be understood.

Pile Protection by Concrete

A NEW method for the protection of piles under ground or water, by means of concrete, has been invented by Imar A. Stempel, of Clearwater, Fla. As shown in the accompanying cut, the essential part of the device is a cylindrical mould made to surround the pile, and into which the protecting sheath of concrete is poured. This mould is made of two semi-cylindrical forms of galvanized iron, whose longitudinal edges are covered with compressible material closing in a water-tight joint, and held in position by jointed clamps, thus enabling the mould to be placed around any pile. After the water has been pumped out of the mould—in case of protecting a pile in water—concrete is filled in, and the mould remains in position until the concrete has hardened.

The advantages of the invention are its unlimited durability, its immunity from ravages of the teredo and other destructive animals, its simplicity and cheapness.



APPARATUS FOR REINFORCING WOODEN PILE WITH CONCRETE.

Rock of Faces

A FEW miles from the city of Saratoga, New York, stands a curious formation which has been called the "Rock of Faces," on account of the many

"The Rock of Faces."
Near Saratoga, N. Y. Outlines contain numerous likenesses to human face.

indentations in its surface which are surprisingly similar to the features of human beings and animals. Looking at the entire profile of the rock, it strongly resembles the head of a woman, including the arrangement of the hair, as well as the forehead, nose, and mouth. The indentations on the right side of the rock however, contain no less than three distinct faces, two of them being on the upper right-hand corner. By turning the picture to the left, and looking at the upper left-hand corner, the face of an old man is seen distinctly; while directly above the center is the face of a dog.

As shown by a comparison with the man standing at the right of the rock, this curious piece of Nature's handiwork is only about thirty feet in height. It is an outcrop of a bed of rock lying beneath the surface, and is the result of a long period of weather erosion.

Life-Saving Apparatus for Mines

RECENT disasters in collieries have called special attention to the need of an efficient device which will enable rescue parties to penetrate the shafts even though filled with poisonous gases. A successful device for this purpose has been developed in Germany; and in that country every coal mine is, by law, required to be provided with the apparatus in the proportion of one set to every twenty miners.

The device, which is shown in the accompanying illustration, is a self-contained breathing apparatus carried by the rescuer. It weighs less than twenty pounds, and has the great advantage of rendering the wearer entirely independent of any connection with the outer atmosphere. He can go where he will, and has thus a wider range of operation than with the ordinary diving apparatus supplied with air through a tube connected with a pump on the surface. He breathes into a bag fastened in front of him. All the carbon dioxide breathed from his lungs is absorbed by means of caustic soda; and the nitrogen left is mingled with a new supply of oxygen from the cylinder of compressed gas carried behind him, the flow of which can be regulated as needed.

German Respiratory Device for Use in Poisonous Atmosphere.
A—Soft rubber mask; *B*—Oxygen chamber; *C*—Regulating device; *D*—Bag for caustic soda; *EE*—Air tubes.

During the scenes of the recent terrible disasters in France, rescue parties sent by the German Government did good work with this apparatus.

Are you worried by any question in Engineering or the Mechanic Arts? Put the question into writing and mail it to the Consulting Department, TECHNICAL WORLD MAGAZINE. We have made arrangements with the American School of Correspondence to have all such questions answered by members of its staff of Instructors. If the question asked is of general interest, the answer will be published in the magazine. If of only personal interest, the answer will be sent by mail, provided a stamped and addressed envelope is enclosed with the question. Requests for information as to where desired articles can be purchased will also be cheerfully answered.

Single-Phase Alternating-Current Motor

Question: Please explain the commutator-type single-phase alternating-current motor.—*E. G. R.*

Answer: The commutator-type single-phase alternating-current motor is a series-commutator type of motor, and does not differ in principle from the direct-current series motor. It is particularly suited for railway work because it has the same desirable characteristics as a series motor. At first thought it may seem strange that a motor built on the same lines as a direct-current machine should operate on an alternating-current, as it might seem as though the motor would tend to turn first in one direction and then in the opposite direction with no resultant motion. This, however, is not the case, because the direction of rotation of a motor depends upon the relative direction of its field and armature current. If, now, the field were maintained in a constant direction, and the armature supplied with alternating current, then, it is true, the tendency would be to rotate first in one direction and then in the other. The alternating current, however, is supplied to the field in series with the armature, so that, when the direction of current in the armature changes, it also reverses in the field, the result being that the relative direction of current in the field and armature is constant, and the motor has therefore a tendency to turn continuously in one direction as long as the alternating-current power is supplied.

There are certain modifications of the ordinary direct-current series motor required to adapt it for alternating-current work. It accordingly has usually a larger number of field poles; and the entire magnetic circuit of frame, cores, and pole-pieces is carefully laminated. The number of commutator segments is also increased, thus reducing the number of armature turns per coil; and special features are introduced to prevent sparking—such, for instance, as the so-called "compensating windings" on the General Electric type of motor, which, it is claimed, entirely neutralize the effect of armature distortion. The single-phase motor is, then, a refined and highly perfected type of direct-current motor, and this explains the fact that it will operate equally well on either alternating- or direct-current circuits. In fact, some claim that it will operate even more efficiently on direct current than the regulation direct-current motor itself.

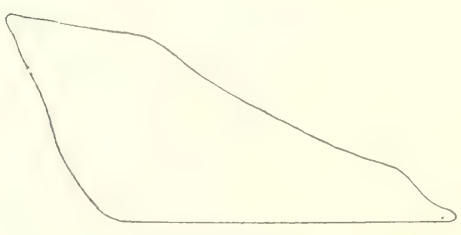
Amperage of Motor-Cycle Battery

Question: In testing the battery of a motor-cycle, I find that the amperage of the whole battery is only slightly above that of a single cell. Is this the regular showing, or is something wrong? What is the regular showing of a single cell against that of the whole battery of three cells?—*J. B.*

Answer: You do not state how you have these cells connected, whether in series or in parallel. If you have the cells connected in series, as is probably the case, then the current of the whole set should be no greater than the current of a single cell, but the voltage would be equal to the voltage of a single cell multiplied by the total number of cells. If you have the cells connected in parallel, then the voltage of the set would be the voltage of a single cell, and the current would equal the current of a single cell multiplied by the number of cells in parallel.

Indicator Diagram

Question: What are the faults with the following indicator diagram?—*F. R. G.*



Indicator Diagram.

Answer: The diagram shows too early admission. Admission line curves backward instead of being straight and perpendicular to the atmospheric line. The diagram also shows cut-off, release, and compression too early. When the valve is of the plain slide-valve type, all the events are likely to be too early if one of them is. The reason for the event being too early is due to the fact that the eccentric has too much angular advance. The angular advance should, therefore, be decreased in order to remedy the faults.

Sparking Trouble in Generator

Question: We have a 75-kilowatt direct-current 220-volt generator that is giving us a great deal of trouble by sparking. We have tried every known remedy with no improvement. The generator has 6 poles and 119 commutator bars. We never before saw an odd number of commutator bars with an ordinary D. C. generator. Is this a correct construction? We fear it is not, and that this is the cause of our difficulty.—*R. B. A.*

Answer: The fact that your dynamo has an odd number of segments does not necessarily indicate that there is anything wrong with the machine, as, with certain types of windings, an odd number of segments on the commutator will necessarily result.

Just what the reason for the sparking may be, it is impossible to state definitely, as there are a multitude of causes for this trouble, any one of which might apply to this particular case. Among some of the common causes of sparking may be mentioned: Machine overloaded, brushes not set at the proper point, commutator rough or uneven, brushes making poor contact with the commutator, short circuit in armature, open circuit in armature, ground in armature, field magnetism weak, etc.

Various Electric Problems

Question 1: I notice an advertisement stating that a 75-light dynamo, 6.6 amperes, is wanted. Does this mean 6.6 amperes per lamp; and if it does, will the dynamo have a capacity of 495 amperes?

Question 2: If a dynamo is rated at 6 amperes, will it have a capacity of twelve 16-candle-power lamps?

Question 3: What is meant by a three-phase 25-cycle generator?

Question 4: What is meant by spelling "ohm" backwards, or "mho?"

Question 5: What is meant by hysteresis?—*W. B.*

Answer 1: The 75-light 6.6-ampere dynamo refers to a constant-current arc machine, in which the lights are connected in series, the total current supplied by the machine being 6.6 amperes, which passes through all the lamps; and the voltage of the machine would equal the voltage of a single lamp *multiplied by* the total number of lamps. Thus, supposing the lamps required 80 volts for their operation, then the voltage of the machine would be 6,000.

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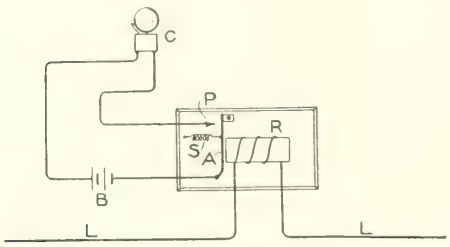
NO STROPPING NO HONING.

Answer 2: If this machine is a constant-potential 110-volt dynamo, then it will have a capacity of twelve 16-candle-power lamps, since a 16 candle-power 110-volt lamp requires about ½ ampere for its operation.

Answer 3: Supposing we have a single-coil armature rotating in a magnetic field, the ends being connected to two slip rings. We shall then have a single-phase alternator. The voltage and current will start at zero, rise to a maximum in one direction, fall to zero, rise to a maximum in the opposite direction, and fal back to zero. This series of changes in voltage or current is called a *cycle.* If, now, we had three such armatures mounted upon the same shaft, but staggered 120° from one another with respect to their windings, and all rotating in the same magnetic field, we should then have a three-phase generator. In this fundamental type, we should have six slip rings; but, by proper interconnection, the number can be reduced to three, which is the ordinary number for a three-phase machine.



Connections of Bell-Ringing Relay on Telegraph Line.

The meaning of the term "cycle" has already been explained; and if this machine made 25 cycles per second, we should have a three-phase 25-cycle generator.

Answer 4: The ohm is a unit of resistance; and it has been suggested, since conductance is the reciprocal of resistance, that we use as a unit of conductance the word "ohm" spelled backwards, or "mho."

Answer 5: Hysteresis is that property of magnetic material by virtue of which the magnetic induction lags behind the magnetizing force producing it. In other words, the magnetic induction does not reach its maximum value quite as soon as the magnetizing force; but there is a slight time lag, so that the changes in magnetic induction fall behind the changes in magnetizing force, and accordingly the two do not reach their maximum and minimum values simultaneously.

Bell on Telegraph Line

Question: There is a telegraph line between two houses. It is a metallic circuit. Can an electric bell be connected at each end so that the bell at one end will ring when a person is calling at the other end?—*A. H. S.*

Answer: We assume, of course, that this telegraph line is operated on the closed-circuit system, so that current is flowing all the time except when one of the keys is open. You might have a relay cut in the circuit at each station, so arranged that when the circuit is opened the armature will be drawn back by means of a spring, thus closing a local circuit containing a bell and battery. This would be on the principle of the relay used in long-distance telegraph lines, except that the relay armature would make contact on opening the circuit instead of making contact upon closing the circuit, as is ordinarily the case.

This can be done as shown in the accompanying sketch, in which *R* represents the core of the relay, which is connected directly in series with the line *LL*. *A* shows the armature, which is drawn toward the core of the relay as long as current flows through its coils. When the line is open, the core of the relay loses its magnetism, and the armature is drawn back against the contact *P* by means of the spring *S*, thus closing the local circuit through the battery *B*, causing the bell *C* to ring.

Size of Lintel

Question: What should be the size of lintel of the type shown in the accompanying diagram? Span between centers of bearings, 7 feet. Wall, 20 inches thick. Floor load, 200 lbs. per square foot. Columns spaced 15 feet from wall.—*M. P. D.*

Answer: In this case the piers at side of opening are sufficiently heavy to consider the wall over opening as arching, as shown by dotted lines.

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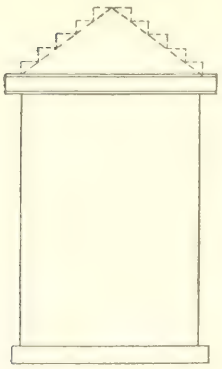
Wall load=7×3.5×1.67×115=4,697 lbs.



LINTEL.

The full floor load should be provided for. The wall load is not a uniformly distributed load, and moment should be calculated by assuming load between center and end of girder as acting one-third the way from the center of the girder.

Bending Moment of floor load = ⅛×200×7.5×7×7×12 = 110,200 inch-pounds

Bending Moment of wall load = 7×3.5×1.67×115×2.33×12 = 65,500 inch-pounds

175,700 inch-pounds

The moment in foot-pounds of wall load can be obtained, also, by the use of the formula

$$M = \frac{p\,l^2}{12}$$

where p is the weight of a square foot of masonry of the given thickness, and l the span.

If the allowable fiber strain is 16,000, this gives a necessary section modulus of 11.0.

Two 7-inch 9.75-lb. I-beams have a total section modulus of 12.0, and would therefore be sufficient.

In this calculation the strength of the angle riveted to the channel is not considered in the capacity of lintel.

Sparking Device—Speeds for Sprocket Gearing

Question 1: Will you please let me know if a gas-engine sparking device can be operated by alternating current.

Question 2: How do you calculate the speeds for sprocket gearing?—*C. E. S.*

Answer 1: It is perfectly possible to ignite a gas engine by means of alternating current, the most common source of supply being the alternating-current magneto. This machine will produce two sparks at each revolution of the armature; and in order that these may occur at exactly the proper instant, it is positively driven by gears. This form of magneto has no brushes, and only one contact from which the live wire is carried.

The accompanying illustration shows an alternating-current magneto. The discharge of the armature serves the same purpose as the spark coil, so that no spark coil is needed. These machines, as ordinarily made, are about twice as heavy as a direct-current magneto, and will give a spark at as low as 50 or 75 revolutions per minute. In order to spark properly, however, the alternator requires several hundred revolutions.

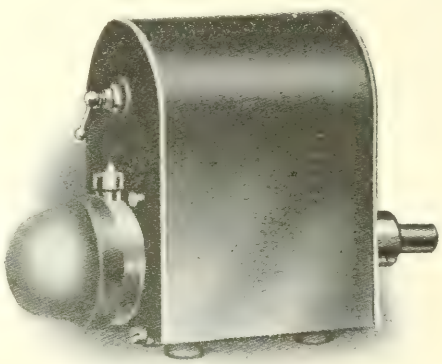
Answer 2: The same principles hold in sprocket gearing as in ordinary belting with pulleys, except that we use the number of teeth in the case of sprocket gearing, instead of using the diameters of the pulleys as in figuring belting. The following formula can be used:

$$r : R :: T : t,$$

in which R = Number of revolutions of the driving shaft; r = Number of revolutions of the driven shaft; T = Number of teeth on the driving sprocket; and t = Number of teeth on the driven sprocket. For instance, supposing there are 50 teeth on the driving sprocket, and 10 on the driven sprocket, then the driven shaft will make 5 times as many revolutions as the driver. We can get at this mathematically by solving the proportion for r, which gives us

$$r = \frac{50}{10}R = 5R.$$

Accordingly, the driven shaft will make 5 revolutions to one turn of the driving shaft.



LOW-TENSION TYPE OF ALTERNATING-CURRENT MAGNETO.

RUSH-COUPONS!

AMERICAN WRITING PAPER CO. RADEO MILLS HALF LIFE QUALITY GUARANTEED

Cut out this Advertisement, attach to your business stationery and mail to us—or write on your regular letterhead.

In return we will send free 50 RUSH COUPONS (printed on COUPON BOND paper).

Pin one of these RUSH COUPONS to any order. It will save you time and worry.

Let up put a pad of these Coupons on your desk with our compliments.

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40 Mill Street, Holyoke, Massachusetts

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Then you know what it means to have the bristles coming out of your shaving brush, sticking in the lather and getting on the face. Can you realize how much easier and pleasanter it will be to shave with the right kind of a brush? The new **Everlasting aluminum shaving brush** is made so that the hairs can **never** come out; by a new method they are riveted with an aluminum ferrule. Use the brush a year, then try to pull the bristles out. If you can pull out a single bristle, we'll give you a new brush free. This is our positive guarantee. Brush is made of very best French bristles, cemented and set in pure aluminum ferrule with a black ebony handle. Introductory manufacturer's price, 25c. **Aluminum Brush Co., 285 E. Madison St., Chicago.**

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are like the Glue, unequalled, the best of their kind in the world, and are put up in convenient and attractive pkgs.

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Life Stories of Successful Men

WILLIAM H. BROWN

By DEWEY S. BEEBE

"THE builder of the Pennsylvania Railway System."—The speaker stopped, and a stillness came over the directors' meeting as they all turned to look at the man referred to—William H. Brown, for thirty-two years Chief Engineer of the Pennsylvania Railway; the man who took charge of the construction work when the railroad was but a tortuous single track between two cities; who rebuilt it, expanded it, grew up with it, and who now sat before them about to withdraw from active service. Robust and hearty, as he was, at seventy years of age, the rules of the Company compelled him to retire. Here was the man whose initiative had made possible their early dreams of a great railway system, the man who had met the demand for quicker service by building shorter routes; who had spanned rivers and torn down mountains at the call of some struggling manufacturing town; the man who had pushed his road where others could find no path; whose tireless energy had won for himself renown, for his road, success, and for Pennsylvania, the foremost place among industrial communities.

"The builder of the Pennsylvania Railway System!" "In the front rank of the country's master-builders!" It was a great tribute, but he had won the title by long years of hard service in his calling. From an obscure beginning, he had reached the forefront of his profession. And as his comrades praise his work through nearly half a century of road-building, he asks himself, then, why has this honor come to him. At the zenith of his fame, he pauses to reflect.

He is carried back in memory to Little Britain, Lancaster County, Pennsylvania, where he was born on the 29th of February, seventy years ago. There he grew up like other fellows. He was apt with tools, and a good carpenter at seventeen. He went to High School in Philadelphia, but longed for the outdoor life. He bought a turning lathe with a little money he had saved up, cut out hickory handles for tools and sold them for 3 cents apiece! Then he went out lumbering one summer; and with the money he earned in this way, purchased a simple surveyor's instrument. How delighted he was when he could get out of an afternoon along the hillside and lay out farms with the help of some borrowed deeds! And a little later he entered the Third District Surveyor's office of Philadelphia, and helped survey the first passenger railway in that city.

But he must have been about twenty-five years old by that time—to be sure, that was about the time the war broke out. How well he remembers the circumstances! It was just after the first battle of Bull Run. The Union troops had been beaten back, and Washington was threatened. Tom Scott, Assistant Secretary of War, must have some correct plans of the country along the Potomac. He applied to the Chief Engineer of the Survey Department of Philadelphia, Strickland Kneass. When Kneass received the letter, he thought the matter over, and finally said, "Well, I guess I'll have to send young Brown out on that job. Just tell him to report to me at once."

So he, "young Brown," started making plans for the Union Army. Here he had the chance to do real engineering work, and in the fierce struggle of the next year he settled definitely the course of his life work. His real fitness for civil engineering, the ambition of his boyhood, was tested in that fiery crucible

There's MONEY in Smoke

THE Peck-Williamson Underfeed Furnace will save you the money wasted and lost in the smoke and gases which escape up and out your chimney from that old Overfeed furnace. It will extract more heat from a ton of the cheapest grade coal than you have ever obtained from a ton of the highest grade. Satisfied users from all sections give voluntary testimony that the

Peck-Williamson Underfeed Furnace

Saves 1-2 to 2-3 on Coal Bills

Several months ago we published a letter from Mr. Howard Shordon, Fort Wayne, Ind., telling his experience. A gentleman from Virginia recently wrote Mr. Shordon, asking further information. Extracts from his reply, follow:

"In reply would state that I am pleased with the Peck-Williamson Underfeed Furnace and consider it the most economical furnace on the market. Prices of coal in this city are as follows: Anthracite $8.00, Soft Lump $5.50, and West Virginia Slack $2.25 per ton. I used less than ten tons of the West Virginia Slack to heat my eight-room house last Winter—heating my kitchen with the furnace and using gasoline for cooking purposes, making my entire fuel bill for the Winter $22.50 for coal and $5.00 for gasoline.

"Last year we used a base-burner stove and burned wood in the kitchen, and our fuel bill was $32.00 for coal and $15.00 for wood, making $47.00 for fuel and *only heating three rooms.*"

Note the saving. In many cities, slack coal is much cheaper than it is in Mr. Shordon's home, and of course in such cases, the saving would be much greater. We've literally hundreds of such letters.

Let us send you an illustrated *Underfeed* booklet, giving full description of furnace and crowded with fac-simile testimonials of satisfied users. Heating plans and services of our Engineering Department are at your command—absolutely FREE. Write to-day and please give name of local dealer with whom you prefer to deal.

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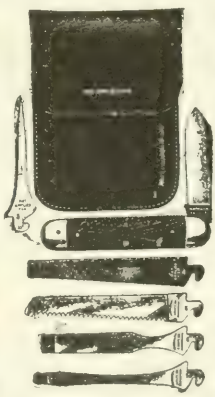

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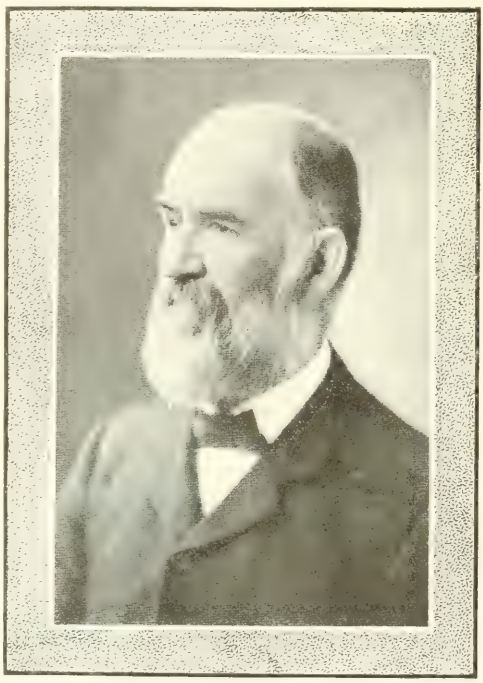
A. W. Longfellow, Jr., Archt., Boston

where thousands measured up their skill against one another, and tried out the sterner fiber of their characters.

Colonel Scott sent him to Alexandria, where he was to draw the plans of the country south of the Potomac. They locked him in a room and guarded the house so that no spy could steal the charts. Here was a distasteful job; but he "plugged ahead," and when he reported to his Colonel with the finished plans, Scott saw he had no ordinary draftsman on his staff, but a promising civil engineer, and he decided to give him a chance.

He was assigned to McClellan's army, and worked in various capacities along the line. The army commissary wagons dug up the roads. These had to be repaired, bridges built, etc. Soon he was given charge of the Orange, Alexandria & Manassas Gap Railway. There was difficult and daring work to be done—bridges to be built or torn down without notice, just as the fortunes of war dictated at the moment. It meant traveling far in advance of the army to clear the way. Out into the enemy's country, sometimes ten miles beyond the pickets, where the harassing cavalry might swoop upon them at any moment, they would go about their work with all the reckless daring of spies, but none of their protection.



William H. Brown.
For 32 years Chief Engineer of the Pennsylvania Railway System.

Ah, that was desperate work. And now he recalls a morning in May. He was with a force of about a thousand men, protecting the roads south of Strasburg. It was still early morning, when he got up to enjoy the break of day. The camp was barely astir, and the dull blue fog of the night was just rising from the plain and slinking back among the trees. Far to the southward he could see where the Shenandoah ran, marked by a crooked line of shadowy trees standing out against the horizon. He heard the sound of hoofs, and then an orderly appeared out of the shadows, and rode up, tossed him a message, and was gone.

The Shenandoah must be bridged within two days! Go ahead. So ran the message. He looked up after the horseman, as if to call him back. Then he read the command again, . . . within two days. He turned and looked again at those sentinel trees to the southward, figured for a moment, and hastened to the engineering corps.

As he looks back upon it now, he cannot tell how it was done. But at 9 o'clock in the morning two days later, he rode back to camp and reported "done" to one of the toughest jobs he had yet undertaken. A bridge 430 feet long, completed in 48 hours! He was proud of it, but the Colonel could not then stop to ask him how it was done. It was enough that he had obeyed orders.

The troops were marched across the bridge to the town of Front Royal, where they encountered the enemy. They were repulsed, and at noon forced back across the bridge.

The regiment were resting a few minutes, their guns beside them, themselves tired, hot and dirty after a hard morning's fighting, when again the orderly came galloping up to Engineer Brown—"Burn the bridge across the Shenandoah!"

Burn the bridge that he had just fin-

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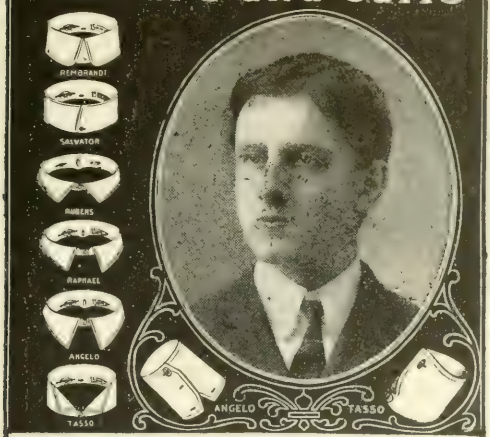

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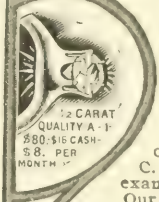

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Send first payment with order, or if you prefer, we'll ship diamond C. O. D. $16.00, subject to your examination.

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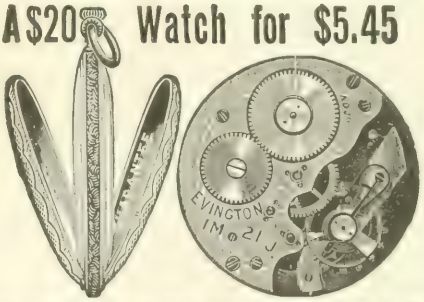
The **TECHNICAL WORLD MAGAZINE**

Chicago, Ill.

A $20 Watch for $5.45



These figures tell exactly what we are doing—selling a **$20.00 watch for $5.45.** We don't claim that this is a $40.00 watch or a $50.00 watch, but it is a **$20.00 watch.** A leading watch manufacturer, being hard pressed for ready cash, recently sold us 100,000 watches—watches actually built to retail at $20.00. There is no doubt that we could wholesale them to dealers for $12.00 or $13.00, but this would involve a great amount of labor, time and expense. In the end our profit would be little more than it is at selling the watch direct to the consumer at $5.45. **The Evington Watch,** which we offer at $5.45 is an 18-**21 jeweled,** finely balanced and perfectly adjusted movement. It has specially selected jewels, dust band, patent regulator, enameled dial, jeweled compensation balance, **double hunting case, genuine gold-laid** and handsomely engraved. Each watch is thoroughly timed, tested and regulated, before leaving the factory and both the case and movement are **guaranteed for 25 years.**

Clip out this advertisement and mail it to us to-day with your name, postoffice address and nearest express office. Tell us whether you want a lady's or gent's watch and we will send the watch to your express office at once. If it satisfies you, after a careful examination, pay the express agent $5.45 and express charges and the watch is yours, but if it doesn't please you return it to us at our expense.

A **25-Year Guarantee** will be placed in the front case of the watch we send you and to the first 10,000 customers we will send a beautiful gold-laid watch chain, Free. We refer to the First National Bank of Chicago, Capital $10,000,000.

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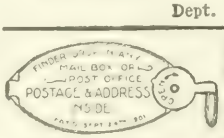
Dept. 403, CHICAGO



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ished in record time, the bridge that he had worked steadily upon for two days and nights, and had completed at the risk of his life! Such were the caprices of war. Yes, and it must be done quickly, too, or Ewell's cavalry would be upon them at any moment. Once more calling his men, they rode back to the scene of their triumph of two days' building, and with their own hands set fire to the structure they had so proudly completed.

But this was only one instance, for twice during the summer he built all the bridges on the line. Once during the war he built a military bridge over the Rappahannock River, near Culpepper, Va., in four days, in order to get supplies to General Pope's army.

But late that summer, 1862, he was taken down with that great foe of the camp, typhoid fever, and was given furlough home. Then Mr. Scott assigned him to the Panhandle Road in November, 1862. Thus he began his life work with the great railroad system which ever after claimed his undivided attention. His progress was now very rapid. From one office to another, first on one road then another, from division to division, until, on August 1st, 1874, he was appointed Chief Engineer of the Pennsylvania Railway.

It was during this time—in January, 1870—that he was appointed resident engineer of the Middle Division of the Pennsylvania Railway, at Altoona. Here he built the great Altoona car-repair and maintenance of way shops.

So he recalls the incidents of his life. And then some of the various projects which he had guided flashed in rapid succession through his mind. There was the bridge over the Susquehanna, west of Harrisburg, the largest stone arched bridge in the world; the elevated road through Newark, New Brunswick, and Elizabeth, N. J.; two stations at Harrisburg; rebuilding the Union Station at Pittsburg in 1877; rebuilding the Jersey City station four times; two bridges over the Raritan river; new line from Philadelphia to Harrisburg; and, which he considered his greatest feat, the building of the Broad Street Station, Philadelphia. This was the first station of its kind ever constructed. The length of the train shed is 598 feet, and it is 354 feet in width. Its great mantle-like roof is supported on twenty trusses.

But even he, as he sits reviewing his life, cannot recall all its incidents. He knows that it had been his part to solve some of the most difficult engineering problems of his day, and there he lets it rest.

The fact that he was in a position to profit largely by the great prosperity of his road, yet never speculated, is but another monument to his sturdy character. Few men to-day can point to so many tangible evidences of their life work, can show so many original and successful enterprises as he.

Trained Men

THIS is the day of the trained man. In competition with him, the untrained man, or the poorly trained man, cannot maintain himself. Do not be afraid of too much theory. Never was good practice which was not preceded by and based upon good theory. Let your theoretical training be broad and deep. It is your only sure foundation for the best work.—HENRY S. PRITCHETT, President of the Massachusetts Institute of Technology.

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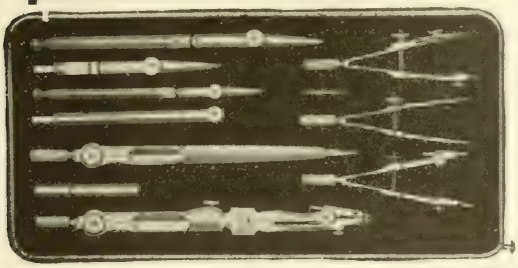

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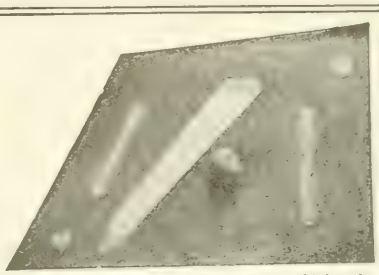

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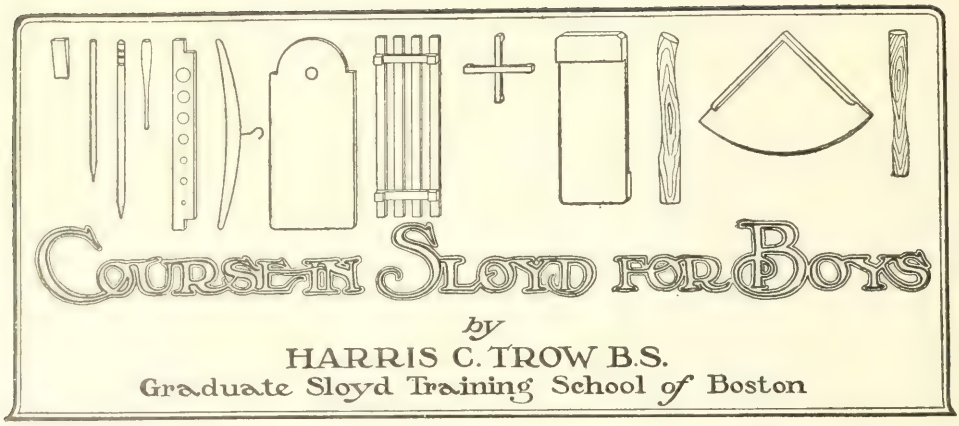

Sixth Lesson—Model No. VI—Bench Hook

THE bench hook and its use have already been discussed in the Third Lesson. In the present lesson, the method of constructing this important and useful tool will be described. A perspective view of the model is shown in Fig. 1, while the working drawing in plan and side elevation is shown in Fig. 2.

The new tools to be used are a countersink, Rose, price 20 cents; and a screwdriver, 4-inch, round, price 22 cents.

The stock should be white pine of ⅝-inch thickness, and wild cherry of 1-inch thickness.

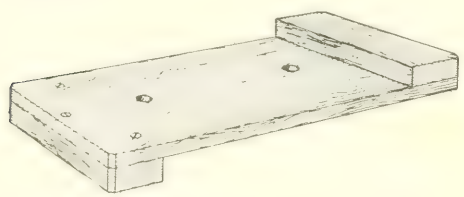

FIG. 1. PERSPECTIVE VIEW OF BENCH HOOK.

As seen in Fig. 2, the model consists of a broad surface 14 by 5½ inches long and ½ inch thick; and two blocks 5½ by 2 inches, and ⅞ inch thick. The white pine is used for the broad surface, and the wild cherry for the two blocks.

Let us proceed, first, to get out the blocks, which should as far as possible be worked in one piece. With the splitting saw and crosscut saw, rough out a piece of one-inch wild cherry about 11¼ inches long and wide enough to finish to two inches. This should be planed smooth and true on one of the two-inch surfaces. Then plane one of the narrow surfaces straight and true at right angles to this. Guage the width of two inches, and plane the second narrow surface, keeping it square with the one first finished. Then gauge the thickness of ⅞ inch on both narrow surfaces, and plane to thickness. Next block-plane one end smooth and square in the bench hook, and measure off the length of 5½ inches from this. In cutting the piece off to length, use the back saw, and cut as closely to dimensions with it as possible, so that there will be very little stock to remove with the block-plane. Then finish to length with the block-plane in the bench hook. The second piece of cherry should be finished in a similar manner, and both pieces should be smoothed with sandpaper and block.

For the body of the model, rough out with the splitting saw and the crosscut saw a piece of the ⅝-inch white pine a little over 14 inches long, and wide enough to finish to 5½ inches. Having got out the stock, plane one broad surface in accordance with the rules given in the Fourth Lesson, taking care that the surface is perfectly level and true, in direction of both its length and width, and that each cut of the plane joins its neighbor without leaving any ridge. The surface should also be tested for "wind," by means of the winding sticks, as explained in connection with broad-surface planing in the Fourth Lesson.

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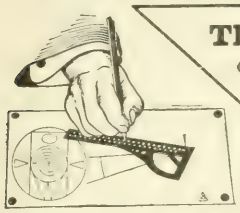

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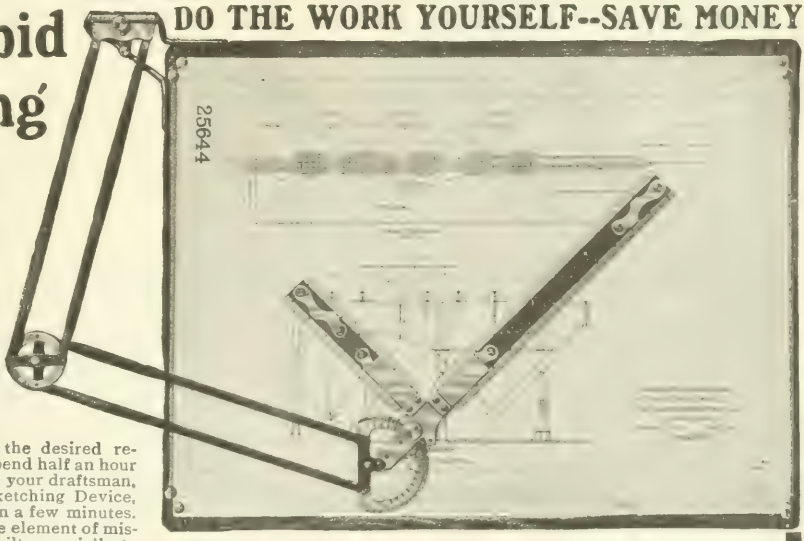

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Next finish a narrow surface at right angles to this broad one, gauge the width of 5½ inches, and finish the second narrow surface. In all these exercises, the eye should be used for testing first, checking the accuracy afterwards with the straight edge and try-square.

The holes, ⅝ inch in diameter, should now be bored with the auger bit and bit brace, as described in the Fourth Lesson. The location of the holes is given in Fig. 2. Start to bore from the finished surface; and when the tip of the bit comes through, turn the work, and finish from the opposite side. After these holes have been bored, guage thickness of ½ inch on both narrow surfaces, and plane to gauge marks. Next plane one end at right angles to both the broad and narrow surfaces, doing this with the jack-plane without the aid of the bench hook, as has already been described. In making these cuts, work from each edge toward the center. Having finished one end, take the length of 14 inches, and finish the other end in a similar way to length. This work should be further finished with sandpaper and block.

The parts of the model are now ready to be assembled. The blocks are to be secured in position by one-inch screws; and these should pass through the soft wood into the hard—or, in other words, through the pine into the cherry—for obvious reasons. Moreover, the screws should not thread into the pine at all; but holes should be bored for them, as otherwise the two pieces could not be brought firmly to a bearing. The holes should be bored in the pine for the six screws, according to the location given in Fig. 2, slightly larger in diameter than the screws themselves, and the holes should be countersunk, so that when in position the heads of the screws will be flush with or slightly below the surface. The Rose countersink in the bit brace should be used for this operation; and the holes at either end should, of course, be countersunk on opposite sides.

One of the blocks should now be placed in position on the pine body, and clamped there by the vise. Using the brad awl, bore through the holes in the pine into the cherry a depth of about ⅝ inch, to make an entrance into it for the screw to follow. Having done this, insert the screws and bring them firmly to a bearing by means of the screwdriver in the bit brace, thus screwing the block firmly against the pine. The second block should be secured in position similarly. It is a good idea to put a little glue between the surfaces to be joined as a further precaution.

The last operation consists in removing the corners, as indicated in the sketch, by means of the chisel used vertically, cutting down upon a piece of waste material to prevent marring the bench.

After the model is entirely assembled, the ends of the blocks should test perfectly square with the broad surface of the bench hook; and the inside narrow surface of each should be exactly at right angles with the length of the bench hook, as the accuracy of the work which can be done with it depends entirely upon these points. If such is not the case, a shaving can be taken off along the narrow surface of the pine and across the ends of the cherry until these conditions are obtained. The corners are removed in order that this may be done easily. Even if the model has been made correctly at the start, it is sometimes necessary to true it up after it has been used for a time.

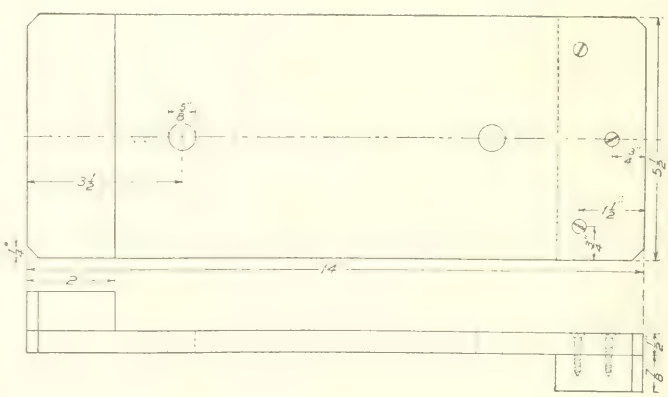

Fig. 2. Plan and Side Elevation of Bench Hook.

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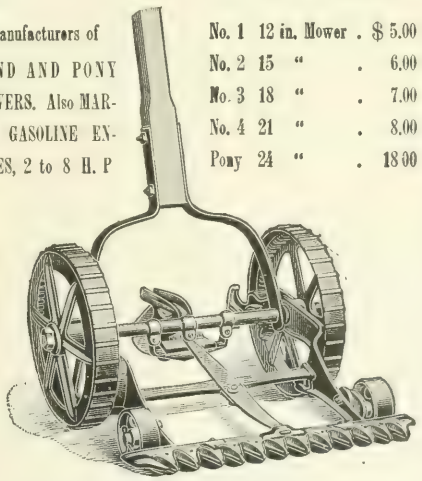

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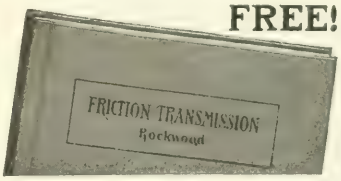

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LITERATURE

BOOKS RECEIVED

Practical Shop Work, Two Volumes. Published by the American Textbook Company. Philadelphia, Pa. Price, $10.00

In reviewing this work, we are impressed with what seems to be the tendency of some subscription book publishers to issue books to be sold on the reputation of standard works.

The chapters on Machine Shop Work and Tool Making are the least incomplete found in the work, and form a very weak apology for an introduction to the other fifteen more or less incomplete sections which the work includes. In the section on Machine Shop Work, little or nothing is found upon the use of bench tools, laying out and handling of work, giving one the impression that this section has been prepared by someone unfamiliar with shop work.

Most glaring omissions are noticeable in automatic screw machines. For example, the best adapted for small work in this line is the Brown & Sharpe Automatic Screw Machine which is not even mentioned. We should expect in a modern treatise on Machine Shop Work to find considerable space devoted to the subject of motor-driven tools, but "Practical Shop Work" has only one paragraph devoted to this important subject. The section dealing with Pattern Making gives practically nothing in regard to the handling of the commonest hand tools used in bench work. In gear cutting, no mention is made of the most important machine for cutting bevel gears, namely the Hugo Bilgrim Bevel Gear Generator, etc., etc.

The subject of Algebra, which is really out of place in a work of this character, occupies a number of pages and yet does not give the reader enough information to solve simple problems of ordinary work.

Foundry Equipment does not touch on the work of the foundryman, but merely describes a few machines even more briefly than such machines would be described in a manufacturer's catalogue.

Other parts may best be characterized as a very weak imitation of a really valuable and well-known work, the "Cyclopedia of Modern Shop Practice," in four volumes, published by the American School of Correspondence. Chicago.

Extraordinarily thick paper has been used to give the work a bulky appearance, making a volume of some 600 pages appear a large book. The editor is a young man of little or no practical experience, employed in the Advertising Department of the B. F. Sturtevant Co. The following extracts from letters from those advertised as associate editors and contributors are typical of many received. No comment is necessary.

John Lord Bacon, Lewis Institute, says:

"I wish to state that I am not connected with the concern calling itself the American Textbook Company, who publish a set of books entitled 'Practical Shop Work,' of which they infer I am associate editor. I am pleased to state that I did prepare the work on Forging for the American School of Correspondence which appears in its work entitled 'Modern Shop Practice.'"

Harry E. Smith, Pratt Institute, Brooklyn, N. Y., says:

"Regarding a publication by the American Textbook Company, I am not on the Board of Editors of this work and have nothing to do with the editing or advertising of the same."

Elementary Course in Mechanical Drawing. Parts 1 and 2. By W. D. Browning, M. E. and F. H. Sibley, M. E. Cloth, Pages 30 and 58. Published by the Browning Press, Cleveland, Ohio. Price. 50 cents each part.

These books are issued in the form of instruction papers for the use of students. Part 1 treats of the instruments used by draftsman, and the instruction following is by means of plates, which constitute a rather novel feature. These plates take up the subjects of straight and curved lines, section lining and shading, lettering and figuring, etc. In part 2 is continued the development of surfaces, helices, and screw-threads; and finally finished drawings, tracings, titles, borders, etc., are presented.

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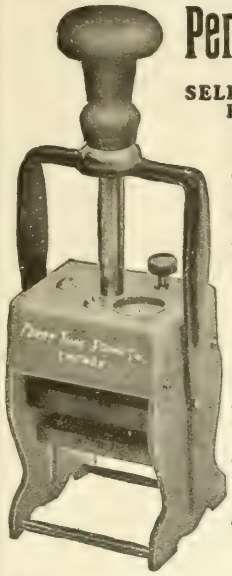

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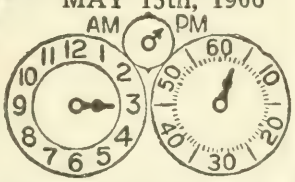

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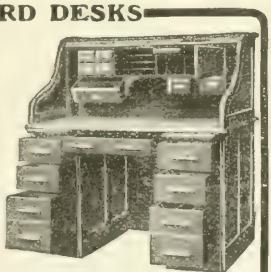

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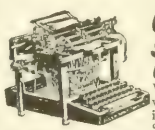

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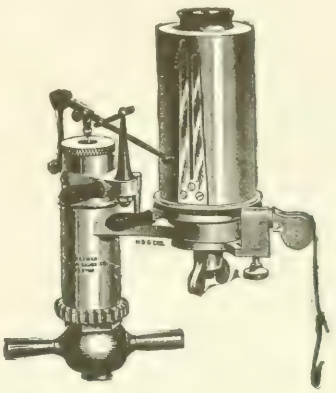

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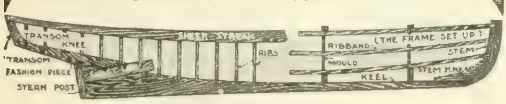

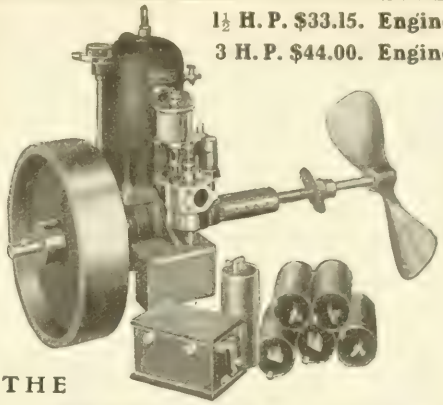

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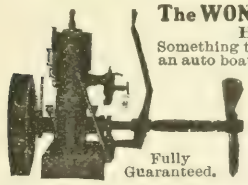

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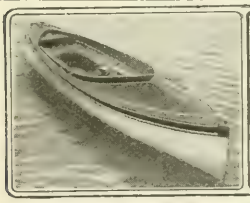

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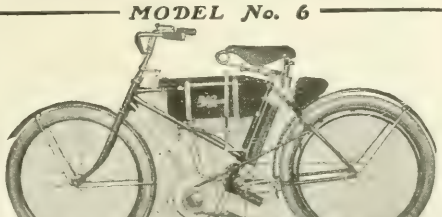

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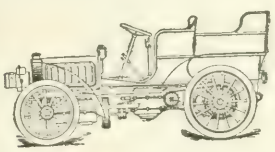

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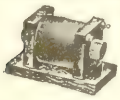

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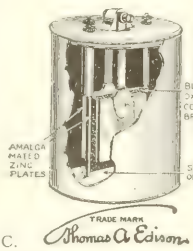

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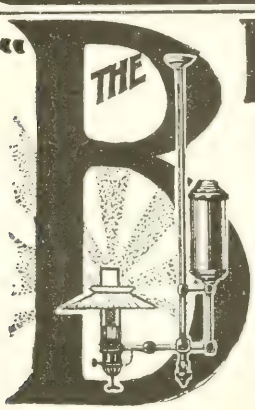

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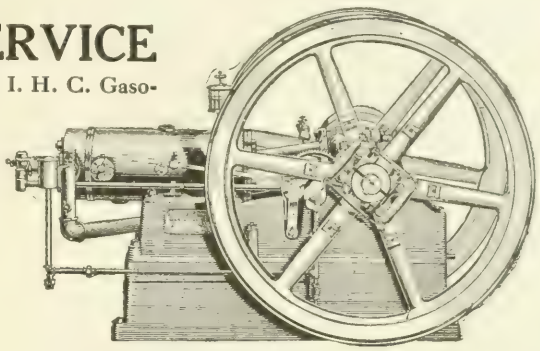

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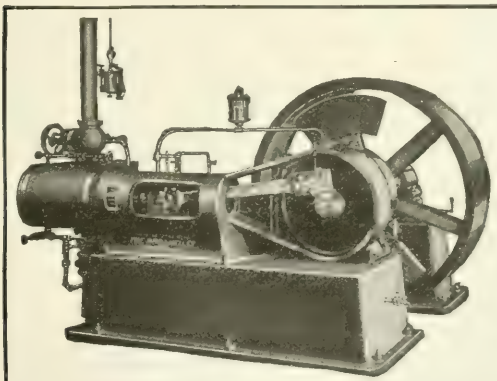

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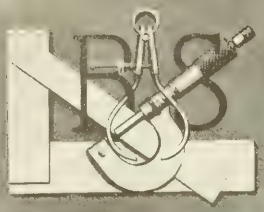

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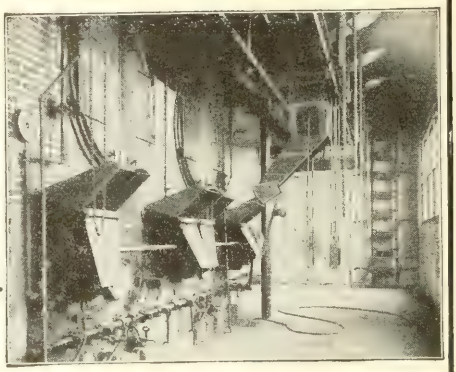

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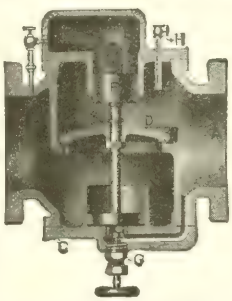

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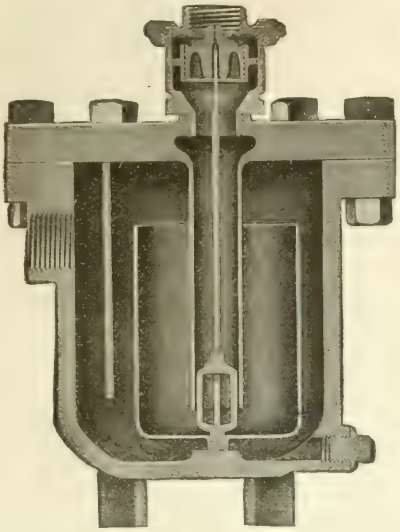

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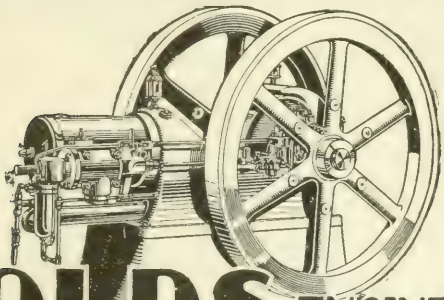

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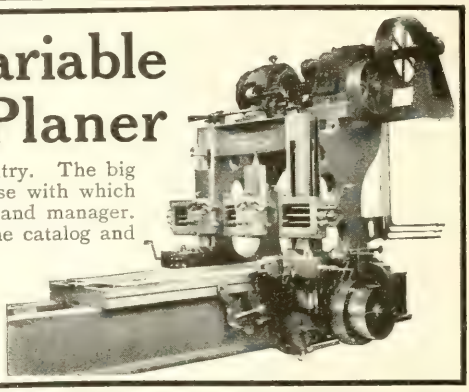

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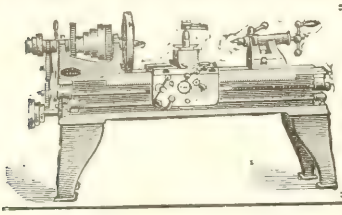

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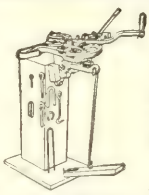

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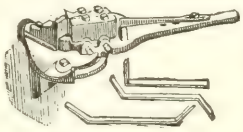

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Which explains why STAR HACK SAW BLADES are so exceedingly popular everywhere. We do not pretend that they are as low in price as other brands in market, but do claim that they are by far the most economical of any to use. You will get a lot of value for your money when you buy STAR SAWS.

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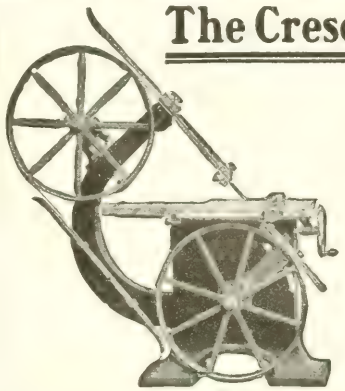

Cuts any angle up to 45 degrees with

TABLE ALWAYS LEVEL

To change angle of saw, turn hand wheel at side of table—that's all; no other adjustments necessary.

Can be tilted while in motion.

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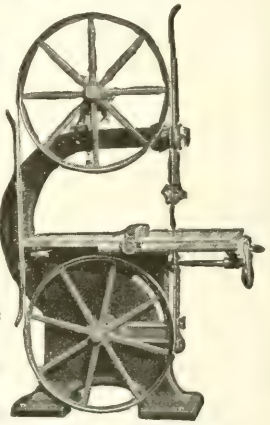
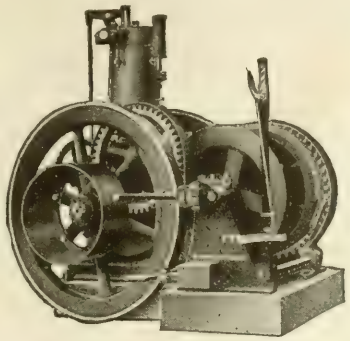


The Crescent Machine Co. No. 127 Main Street, Leetonia, Ohio



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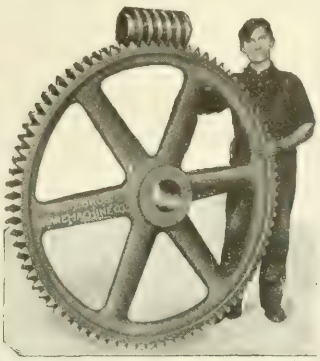

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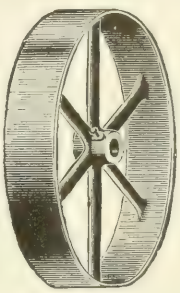

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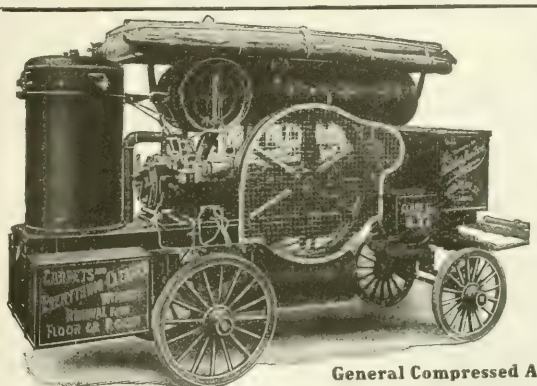

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The Treason of the Senate in June

THE name that David Graham Phillips has given the series of articles he is writing for the **Cosmopolitan** is not a misnomer. **The Treason of the Senate** is a fact.

The Constitution of the United States—Article 3, Section 3—says: "Treason against the United States shall consist only in levying war against them, or **in adhering to their enemies, giving them aid and comfort.**"

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Leave Denver on the Burlington's Yellowstone Park train, the route of which is thro' the interesting formations of Northwest Nebraska; along the picturesque Black Hills (into which inexpensive side trips may be made); over the Big Horn Mountains; past Custer Battlefield, the most tragic upon which our sun shines; and, finally, thro' famed Yellowstone Valley to Gardiner, the official entrance to the Park.

This tour provides for a stay of five and a half days in Wonderland—a complete tour of the Park—coaching each day, viewing what is by far the most interesting scenery on the globe and being entertained at the best hotels. Stay longer, if possible, for this is the finest outing place known. Only extra charge after five and a half days is for hotel accommodations—$4.00 and up per day; after seven days $3.50 and up per day.

After leaving Yellowstone Park, you travel to Minneapolis and St. Paul, following the Yellowstone River thro' Montana, making a bee line thro' North Dakota's fertile fields and crossing Minnesota's Lake Park region.

It would be well to provide for a day or two in and about the Twin Cities, for there is much to do and to see.

Then come home on one of the Burlington's handsome observation trains running over the Mississippi River Scenic Line. This will give you a splendid view of the finest river scenery east of the Rocky Mountains, and, in addition, a cool and comfortable journey.

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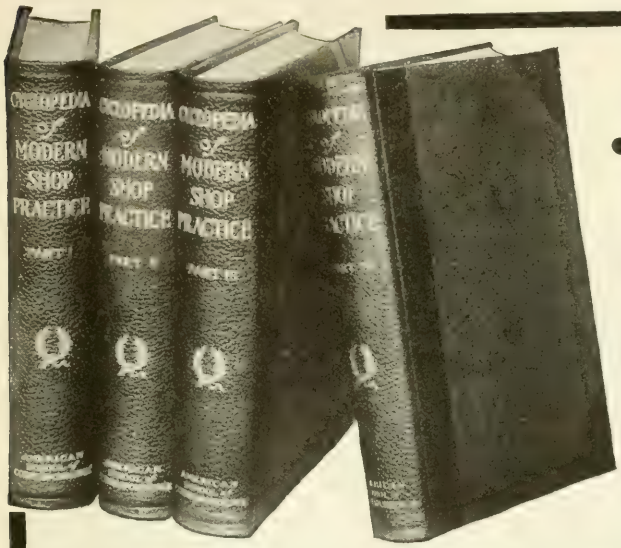

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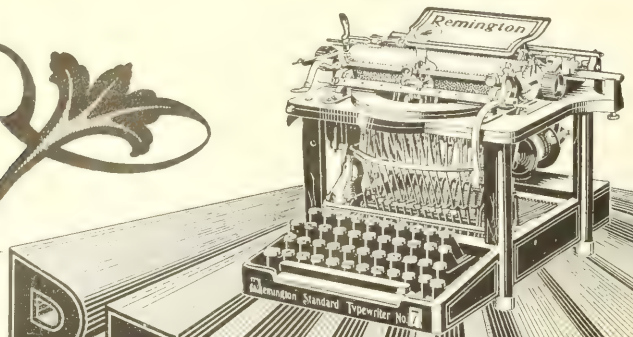

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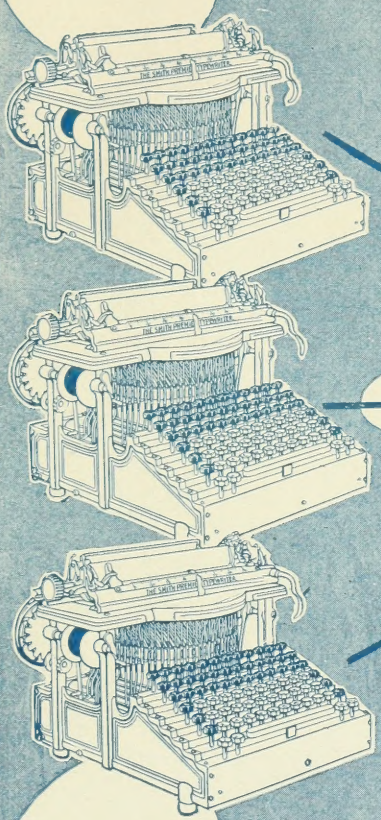

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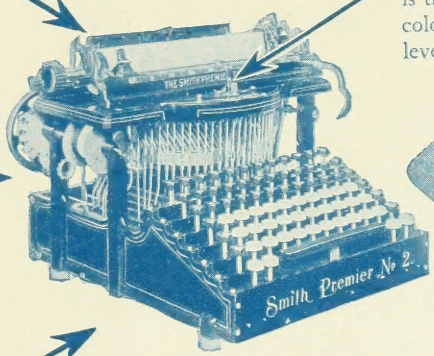

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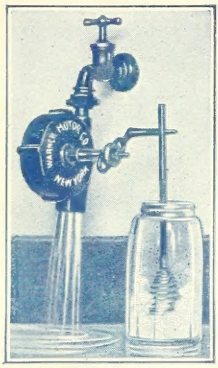

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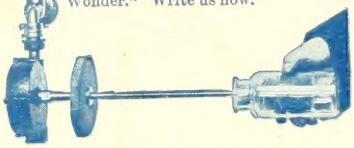

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